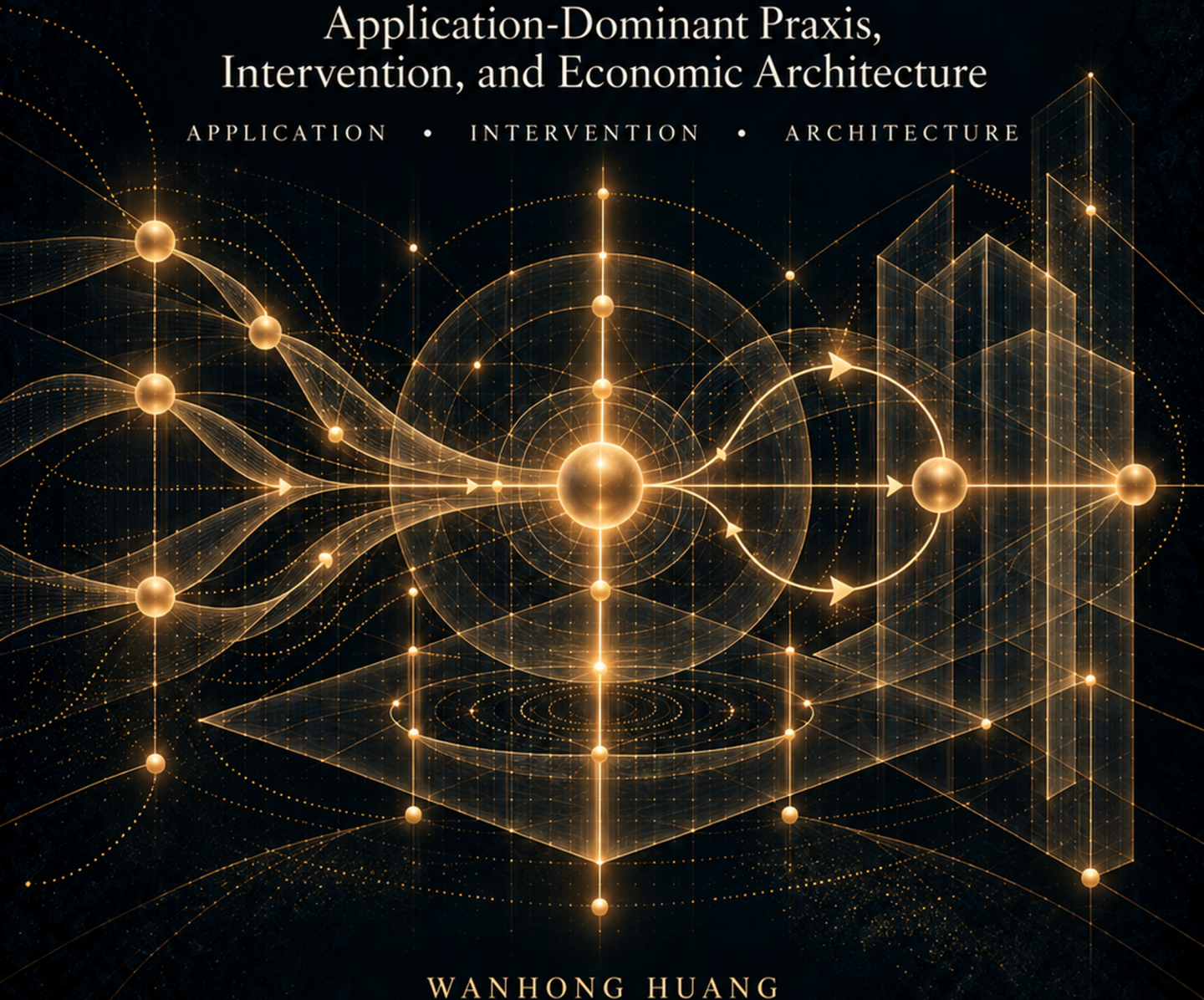


GENERATIVE RELATIONAL ECONOMICS

VOLUME IV

Application-Dominant Praxis,
Intervention, and Economic Architecture

APPLICATION • INTERVENTION • ARCHITECTURE



WANHONG HUANG

GENERATIVE RELATIONAL ECONOMICS

Seven-Volume Treatise

Volume IV

**Application-Dominant Praxis,
Intervention, and Economic Architecture**

Chapters 10–12

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Series Structure

Generative Relational Economics is organized as a seven-volume treatise. Chapter numbering remains continuous across the series.

Volume I. *Foundations, Constitution, and Ontology of Generative Relational Economics* (Chapters 1–4)

Volume II. *Epistemology, Research Praxis, and Relational Inquiry* (Chapters 5–7)

Volume III. *Generative Relational Inquiry and Integrated Research Design* (Chapters 8–9)

Volume IV. *Application-Dominant Praxis, Intervention, and Economic Architecture* (Chapters 10–12)

Volume V. *Allocation, Value, Spacetime, Power, and Epistemic Economy* (Chapters 13–17)

Volume VI. *Artificial Intelligence, Domains, and Economic Order* (Chapters 18–21)

Volume VII. *Research Programme, Disciplinary Interfaces, Limits, and Open Development* (Chapters 22–25)

The seven-volume division is a physical and editorial organization of the same continuous manuscript. Existing chapter identities, section numbering, notation, bibliography records, and conceptual architecture are preserved. The additional physical volume allows the edition to remain within the publisher's 1,050-page ceiling without compressing the typography or splitting chapters.

Preface

This book develops *Generative Relational Economics* (GRE) as an open research programme for studying economic life through relations, generative processes, historical transformation, heterogeneous forms of value, and the conditions under which present arrangements alter future possibilities. Its point of departure is economic, but the questions that must be answered before a relational-generative economics can be stated coherently are broader. A theory of economic relations requires a view of what kinds of realities may be treated as analytically real; claims about those realities require an epistemology; empirical work requires a research praxis and methodology; and economic intervention requires an account of decision and action under incomplete knowledge. The book therefore develops a limited set of broader Generative Relational (GR) foundations before returning to substantive economics.

The resulting architecture should not be read as a claim that economics contains ontology, epistemology, history, law, governance, aesthetics, or the other domains with which it interacts. The opposite discipline governs the project. A domain remains defined by its principal problem-space while retaining explicit interfaces with neighboring domains. GRE draws historical insight from generative relational approaches to history, governance insight from neighboring work on generative relational governance, and normative and aesthetic resources where economic questions require them. Those interfaces remain interfaces. They do not dissolve the boundaries among disciplines.

The central economic concern is the generation and transformation of relational possibilities. Conventional allocation questions remain important, but an allocation does more than change holdings. It may stabilize or weaken relations, generate capacities, alter access, reshape institutions, change the pathways through which heterogeneous values circulate, and modify what later actors are able to do. GRE therefore follows resources beyond the administrative recipient and asks how economic interventions enter relational structures and how those structures develop through time.

This orientation also changes the treatment of value. The book does not assume that all values can be placed in a single common metric. Material, capability, relational, epistemic, institutional, future, and other forms of value may interact without becoming fully commensurable. Their conversion is therefore an economic problem in its own right. GRE asks what happens at conversion interfaces, which actors can define or control those interfaces, what is lost or generated in conversion, how value circulates and returns, and how power and justice appear when heterogeneous values move through unequal relational systems.

Historical time is equally central. Economic processes operate across different temporal scales. Transactions, prices, attention, organizational routines, institutions, trust structures, infrastructures, and intergenerational capacities need not change at comparable rates. The book consequently treats trajectories, delayed generation, path dependence, multiple timescales, and

cross-scale coupling as economic objects rather than as secondary complications. Formal descriptions such as dynamical systems, networks, fields, geometry, category-theoretic structures, or spacetime-like representations are used where they clarify such problems. They remain analytical representations whose scope must be justified locally; they do not establish the ultimate ontology of social or economic reality.

The book also treats research itself as praxis. Historical, interpretive, qualitative, quantitative, empirical, formal, and computational methods provide partially irreducible modes of access to relational-generative systems. Their relation is therefore neither a hierarchy nor a simple synthesis. They can expose one another's blind spots, constrain one another's overreach, and generate revisions of concepts and theories. Research-dominant praxis and application-dominant praxis are likewise related configurations rather than separate worlds. Research contains decisions and interventions; application contains inquiry and learning. Their principal tensions differ, and either may transform into the other as the practical situation changes.

Artificial intelligence makes several of these questions more urgent. Large asymmetries in productive and epistemic capability may persist even where material output becomes abundant. Such asymmetries raise economic questions about ownership, dependence, participation, access, value capture, research orientation, and the relation between productive contribution and social membership. GRE approaches these questions without assuming that capability equality is either possible or desirable. The relevant issue is how heterogeneous capabilities enter relations and how those relations convert asymmetry into power, exclusion, participation, or new generative possibilities.

The programme offered here is deliberately revisable. Earlier GR formulations, including earlier historical and formal proposals, are treated as intellectual resources rather than canonical premises. A useful distinction may later fail in another domain; a formal analogy may lack empirical warrant; a theory may require a narrower scope; an apparently general GR structure may turn out to be economics-specific. Revision is therefore part of the framework's normal development rather than an exceptional repair.

For the same reason, GRE is presented in dialogue with existing economics rather than as a replacement for it. Neoclassical, Marxian, Keynesian, institutional, evolutionary, complexity, feminist and care, capability, ecological, commons, relational, and other traditions have developed objects, mechanisms, methods, and normative distinctions that GRE can learn from. A relational language may sometimes make translation among these traditions possible. Translation does not imply theoretical identity. Some disagreements should remain visible because they concern different ontologies, values, methods, scales, or historical commitments.

The book is consequently best read as an architecture for continuing inquiry. It makes substantive claims, proposes hypotheses, develops conceptual distinctions, and offers formal and methodological resources, while marking open problems and places where counterevidence would require revision. Its intended endpoint is not a closed economic system. It is a research programme capable of entering new relations, being altered by them, and preserving enough of its own history for later readers to understand how those alterations occurred.

Standing of the Work

This volume is a book-length statement of Generative Relational Economics as a developing research programme. Its standing is stronger than that of a preliminary note and weaker than that of a closed theoretical system. The distinction matters because the chapters contain several kinds of intellectual object whose evidential and argumentative status differs.

A *claim* is a proposition for which the book supplies an argument at the level required by its local purpose. A *proposal* identifies a conceptual or theoretical structure offered for further assessment. A *hypothesis* states a mechanism or relation whose standing ultimately depends on empirical, historical, or formal investigation beyond the argument that motivates it. A *heuristic* organizes inquiry without asserting that the represented structure literally constitutes the world. A *formal representation* specifies a mathematical or structural language under explicit assumptions. These categories should remain distinct throughout the manuscript.

The broader GR material in the book has a similarly limited standing. GRE is the principal domain. General ontological, epistemological, research-practical, and application-practical foundations are developed only to the degree required to construct GRE. The volume does not claim to provide a completed Generative Relational Theory across all disciplines. A more general theory would require sustained comparison across independently developed domains, including cases in which concepts useful in economics fail, change meaning, or become unnecessary elsewhere.

Ontological suspension provides the default discipline for that reason. Relational reality and manifestational reality are treated as analytically meaningful without requiring a final metaphysical settlement for every object under study. Formal language may sharpen a relational description, but formal usefulness does not by itself establish ontological identity. A field representation, a network, a dynamical system, a category-theoretic mapping, or a spacetime-like model earns its place through the question it helps answer and the evidence or interpretation to which it can be connected.

The historical standing of the programme is equally important. Earlier GR and GRH formulations are open to correction. The present book may retain an earlier distinction, weaken it, change its status from ontology to heuristic, or set it aside. Such changes should remain reconstructable rather than being hidden by retrospective rewriting. The research programme therefore values provenance, versioned concepts, preservation of negative results, and future re-epistemization.

GRE also declines several forms of premature closure. It assumes no single universal metric of value, no predetermined historical endpoint, no universal formalism, and no methodological monopoly. Generativity itself is not treated as automatically good. A process can generate capacities, relations, or options while also producing domination, extraction, exclusion, or

harm. Normative evaluation therefore remains an independent task informed by, rather than mechanically derived from, generative description.

The volume's relationship to existing economics is dialogical. Existing theories can correct GRE, delimit its scope, or supply better explanations for particular problems. GRE can also provide a comparative relational language through which theories that foreground different objects or scales may encounter one another. The success of such translation must be assessed case by case. Failed translation is itself informative because it identifies theoretical specificity that a common language should not erase.

The same discipline governs application. The book develops application-dominant praxis because economic actors often must decide before knowledge is complete. Decisions remain epistemically regulated, historically situated, normatively contestable, and revisable where reversal is possible. Practical closure is therefore distinguished from epistemic closure. Acting under uncertainty does not convert uncertainty into knowledge; it establishes a provisional commitment whose consequences become part of the next epistemic situation.

The work should therefore be evaluated at several levels: the coherence of its conceptual distinctions, the adequacy of its reconstructions, the quality of its dialogue with existing theories, the warrant of its formal representations, the empirical tractability of its hypotheses, and the practical usefulness of the questions it makes available. No single success at one level secures the others. The open research programme begins from that plurality of burdens.

Guide to the Book

The book is organized into eight Parts. The sequence is cumulative, although individual chapters can be read independently when a reader already accepts the foundations on which they rely.

Part I: Foundations and Constitution of Generative Relational Economics. The opening Part reconstructs the historical conditions under which GRE becomes necessary and possible, surveys the intellectual resources from which it can be constructed, and defines GRE as an emerging economic research programme. The emphasis is disciplinary: the Part explains the problem-space before introducing the broader GR foundations required later.

Part II: Ontology and Epistemology. The second Part develops the ontological view and epistemology used by the remainder of the book. Ontological suspension, relational reality, manifestational reality, representation, evidence, and the limits of inverse inference establish the conditions under which later economic claims can be made without converting analytical representations into final metaphysical commitments.

Part III: Research Praxis and Methodology. The third Part treats research as a historically situated form of praxis. It develops methodological pluralism across historical, interpretive, qualitative, quantitative, empirical, formal, and computational inquiry; then it develops methods for relational inquiry, generative relational inquiry, and integrated research design. Readers primarily interested in empirical or formal GRE can use this Part as the methodological gateway to the substantive economic chapters.

Part IV: Application-Dominant Praxis and Methodology. The fourth Part shifts the principal practical tension from understanding toward decision and intervention under incomplete knowledge. It develops action spaces, practical judgment, risk, reversibility, participation, responsibility, adaptive intervention, and the methodological instruments used for decision and institutional change. Research and application remain coupled throughout.

Part V: Foundations of Substantive Generative Relational Economics. The fifth Part returns fully to the economic domain. It develops the relational architecture of economic systems, allocation as relational intervention, generative and heterogeneous value, and generative spacetime. This Part contains the main conceptual machinery for following resources and values through relational structures across time and scale.

Part VI: Power, Knowledge, and Artificial Intelligence. The sixth Part develops several major consequences of substantive GRE. Power and justice are examined through asymmetry, conversion, capture, participation, and generative opportunity. The epistemic economy extends the analysis to knowledge abundance, attention, curiosity, aesthetic judgment, and research orientation. The final chapter of the Part examines artificial intelligence under radical capability and knowledge asymmetry.

Part VII: Domains and Economic Synthesis. The seventh Part examines selected domains in which GRE can be tested, translated, and limited. The purpose is not to absorb education, research institutions, humanitarian practice, communities, commons, ecology, or other domains into economics. Domain work identifies where GRE is useful, where neighboring theories are required, and where apparently general concepts become domain-specific. The Part concludes with a synthesis of the economic orders made thinkable by GRE.

Part VIII: Dialogue, Research Programme, and Disciplinary Return. The final Part turns the framework back toward economics as a discipline. Existing economic traditions are reconstructed in relational dialogue without ranking or forced unification. The book then states a GRE research programme, identifies interfaces with neighboring GR domains, records limits and open problems, and closes with GRE's standing as an open and historically revisable programme rather than a finished canon.

Readers can therefore enter the book at different points. A reader interested in foundations should begin with Parts I and II. A methodological reader can move from Chapter 6 through Chapter 11. A reader primarily interested in GRE's economic contribution can begin with Part V and return to the earlier foundations as needed. Readers concerned with AI, epistemic economy, power, or justice may begin in Part VI, while Part VIII provides the most direct account of GRE's relationship to existing economics and its future research agenda.

Cross-references are used to keep these entry points possible without pretending that the chapters are independent. Concepts are introduced where they first become structurally necessary, and later chapters should reuse rather than silently redefine them. Where a concept changes status or scope, the revision should be stated explicitly.

AI Assistance Statement

Artificial intelligence has been used as an assistive research and writing instrument in the development of this book. Its uses include structural planning, language revision, comparison of alternative organizations, code generation for manuscript tooling, compilation support, exploration of formal representations, and assistance in maintaining consistency across a long and evolving project.

AI assistance does not function as an evidential authority. External references are subject to a pre-verification rule: a source must be checked against an authoritative or reliable online record and against the claim it is intended to support before the citation is inserted into the manuscript. Bibliographic verification, claim selection, theoretical commitments, normative judgments, and responsibility for the final text remain with the author.

The use of AI is also treated as part of the book's substantive research problem. Abundant generation of prose, models, hypotheses, and technically difficult questions does not eliminate the need for research judgment. Problem selection, historical sensitivity, relational interpretation, aesthetic judgment, normative responsibility, and decisions about theoretical significance remain distinct tasks even when generative capacity is extensively automated.

Because the project is developed through iterative human–AI interaction, intermediate drafts may contain exploratory formulations that are later revised or abandoned. The standing of the published text is determined by the final human-reviewed manuscript rather than by any individual intermediate generation. Revision histories and project materials are preserved where useful so that the development of the programme remains reconstructable.

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Chapter 10

Application-Dominant Praxis in Generative Relational Theory

Chapter 10 develops the domain-general architecture of application-dominant praxis in Generative Relational Theory. Its role within Part IV is to establish the practical-philosophical landscape required before the book turns to concrete decision and intervention methodologies. Part III organized research-dominant praxis around the production, revision, adjudication, preservation, and provisional closure of warranted knowledge. The transition into Part IV changes the governing practical orientation. Consequential action now becomes the principal task even though knowledge, values, institutional conditions, consequences, and future developments can remain incomplete, contested, or partly unknown. The present chapter reconstructs the structure of praxis under that condition.

The chapter therefore begins from a different principal contradiction from the one that organized the research-dominant block. Research can often continue inquiry when warrant remains insufficient for the intended claim. Application-dominant praxis eventually encounters situations in which action, restraint, waiting, refusal, continuation, withdrawal, or commitment themselves carry consequences. The practical configuration must then organize a response while uncertainty remains. Inquiry remains constitutive within this changed orientation through diagnosis, interpretation, evidence generation, monitoring, evaluation, and revision. Their function changes because knowledge now supports a practical process whose consequences extend beyond the epistemic quality of a claim.

This distinction replaces a linear research-to-execution image with a recursive architecture of knowledge and action. Research outputs enter practice with particular scopes, assumptions, uncertainties, provenance, and purposes. Practical use can change their function. Action then alters the relational field, generates new manifestations, redistributes capacities and constraints, and produces evidential traces newly created through intervention. Application can therefore modify the conditions under which later inquiry proceeds. Research and application remain distinguishable praxis modes while also forming a recursive relation through which each can trans-

form the conditions of the other.

The account remains deliberately domain-general. Although this book ultimately develops Generative Relational Economics, theories of economic allocation, value conversion, circulation, production, exchange, institutional economy, and economic power are reserved for later Parts. The present chapter develops a GR-level account of consequential praxis that can later be specialized within economics while retaining interfaces with governance, law, education, medicine, engineering, environmental action, organizational practice, humanitarian intervention, and other domains. Economic examples serve as illustrations within an architecture whose constitutive categories remain domain-general.

The analytical object is therefore broader than decision in the narrow sense. Application-dominant praxis includes the constitution of a practical situation, the formation of a practical problem, the exercise of judgment, the specification and revision of ends, the construction of an action space, the organization of decisions under incomplete knowledge, and the consequences of both action and non-action. It also includes risk, irreversibility, power, participation, responsibility, justice, institutional organization, learning, closure, and the requirements that later methodology must preserve. These elements interact. A decision threshold can depend on reversibility. Reversibility can depend on institutional capacity. Institutional capacity can depend on trust and coordination. Participation can change problem formulation, values, evidence, and action possibilities. Power can shape measurement, evaluation, delay, and exit. Practical closure can therefore be understood only through the relations among these dimensions.

The chapter preserves ontological restraint throughout this analysis. Practical actors require working descriptions of situations, relations, capacities, constraints, institutions, consequences, and possible trajectories, yet those descriptions remain historically situated representations. The practical necessity of acting leaves the epistemic and ontological status of a useful model unchanged unless stronger support is independently established. Application can increase pressure for simplification because decisions require operational categories, thresholds, and responsibilities. The framework therefore treats the provenance, scope, and revisability of practical representations as constitutive parts of responsible praxis across both research and application.

The same restraint applies to normativity. Application-dominant praxis necessarily contains normative commitments because consequential action distributes benefits, burdens, risks, opportunities, recognition, authority, and future possibilities. These commitments retain their normative standing alongside technical analysis and optimization. Epistemic judgment, normative judgment, aesthetic judgment, and practical judgment perform different functions. Practical judgment must often coordinate them without converting their differences into one homogeneous metric. Value plurality, partial comparability, thresholds, protected values, unresolved conflict, and revisable closure therefore enter the ordinary architecture of practical judgment.

Action is likewise treated relationally. An intervention changes more than an isolated target variable. It can modify dependencies, capacities, constraints, institutions, expectations, classifications, trust, option structures, and the future conditions of agency. Non-action can also participate in generation because existing processes continue, opportunities expire, institutions reproduce themselves, and other actors respond. Waiting, refusal, withdrawal, and exit therefore require their own practical

analysis. The relevant question concerns how each practical response participates in the transformation or preservation of the relational field.

This generative orientation makes time especially important. Consequences can be delayed, cumulative, path-dependent, partially reversible, or effectively irreversible. Present action can preserve future options or foreclose them. Institutions can inherit responsibilities from earlier decisions, while later actors can inherit benefits, burdens, risks, infrastructures, categories, and damaged or expanded action spaces formed before their participation. Application-dominant praxis therefore requires temporal horizons that extend beyond the immediate decision moment. Monitoring, maintenance, repair, institutional memory, reopening conditions, and long-horizon responsibility become parts of the practical architecture.

Power enters for the same reason. Practical power is distributed across the sequence through which a situation becomes actionable. Actors can differ in their capacity to define the problem, select ends, authorize decisions, execute interventions, delay or withhold action, construct measurement, evaluate outcomes, or exit an arrangement. Resource, expertise, information, legitimacy, mobility, institutional position, and coordination centrality can become practical power when conversion pathways make those asymmetries consequential. Participation and distributed agency therefore require analysis across the full practical sequence, including stages before and after formal consultation or voting.

Responsibility and justice extend this relational account. Responsibility concerns how decision, action, inaction, uncertainty, institutional role, distributed contribution, maintenance, repair, and long-horizon consequence are connected to positions capable of answer and response. Justice asks how the practical configuration distributes or transforms benefits, burdens, risk, participation, recognition, relational position, generative opportunity, historical consequence, and future conditions. Neither concept is treated as an external ethical appendix. Both are constitutive of application-dominant praxis because practical action changes who is exposed, who can respond, who can revise, and what possibilities remain available later.

Institutions provide the durable medium through which many of these practical relations are stabilized. Mandates, authority, resources, routines, infrastructures, records, coordination mechanisms, trust, conflict, and collective memory affect what organizations and collectives can perceive, decide, implement, preserve, contest, and revise. Collective capability can exceed, redirect, or constrain the aggregate of individual capabilities through relational and institutional organization. Institutional arrangements can generate forms of agency that emerge only through collective organization, while poorly designed interfaces can make highly capable participants collectively ineffective. The chapter accordingly treats institutional and collective praxis as a generative structure in its own right.

Application also produces epistemic consequences. Implementation reveals interfaces, resistance, adaptation, unexpected uptake, missing mechanisms, and previously hidden constraints. Practical failure can generate questions that became visible only through intervention. Successful outcomes can likewise expose mechanisms different from those assumed at the time of decision. The chapter therefore develops a coupling between application and research in which practical experience can generate evidence, theory pressure, revised categories, and research-return triggers. Later knowledge can reinterpret earlier practical episodes through re-epistemization while preserving the distinction between what was knowable at the earlier decision point

and what became visible only afterward.

Continued learning coexists with a requirement for practical closure. Application-dominant praxis requires stopping points sufficient for coordination, commitment, responsibility, and implementation. The chapter therefore develops practical closure as provisional stabilization with preserved conditions for later reassessment. Residual uncertainty and disagreement can remain attached to the closure through records, monitoring, revision conditions, reversal pathways, exit conditions, and reopening procedures. Closure becomes an institutional achievement that permits action while preserving the practical capacity to respond when materially relevant conditions change.

The chapter is organized into six analytical blocks. Sections 10.1–10.2 establish application-dominant praxis and its principal contradiction. Sections 10.3–10.7 reconstruct the practical situation, problem formation, judgment, ends, and action space. Sections 10.8–10.10 develop decision under incomplete knowledge, action and non-action, risk, reversibility, and option structure. Sections 10.11–10.15 examine power, participation, responsibility, justice, and institutional or collective praxis. Sections 10.16–10.17 develop research–application recoupling and practical closure. Section 10.18 then translates the resulting practical architecture into methodological requirements and provides the direct handoff to Chapter 11.

The objective of Chapter 10 is architectural. Universal decision rules, single evaluative metrics, and privileged intervention methods remain outside its intended scope. It establishes the distinctions, responsibilities, and boundary conditions that later applied methodology should preserve when consequential action is organized under incomplete knowledge and historically changing conditions. These include the relation between situation and problem, knowledge and judgment, values and ends, formal possibility and effective action space, uncertainty and commitment, action and non-action, risk and reversibility, asymmetry and power, participation and agency, responsibility and accountability, justice and heterogeneous value, institutions and collective generativity, learning and re-epistemization, and closure and reopening.

Chapter 11 takes this architecture as its practical foundation. It develops the methodological architectures through which diagnosis, criterion specification, evidential thresholds, decision analysis, scenarios, robustness, adaptation, optimization, formal and quantitative modeling, historical and interpretive analysis, participation, intervention targeting, timing, scale, intervention depth, monitoring, evaluation, repair, rollback, and AI-assisted decision support can be selected, combined, sequenced, and revised. The division of labor is deliberate. Chapter 10 specifies the conditions under which methods become practically meaningful and responsible; Chapter 11 examines how different methodological families can satisfy those conditions in actual decision and intervention design. The substantive specialization into Generative Relational Economics remains deferred until the domain-general architecture of knowing and acting has been completed.

10.1 Application-Dominant Praxis

Part III developed the architecture of research-dominant praxis around the production, revision, adjudication, and provisional closure of warranted knowledge. The role of the present section is to establish the complementary praxis configuration

that becomes central when consequential action must be organized under conditions that remain epistemically incomplete. Its objective is to define application-dominant praxis without separating it from inquiry, to preserve praxis as the superordinate category within which research and application are differentiated, to specify the overlap and transformation between the two modes, and to delimit the analytical value of the distinction. The discussion proceeds from the common structure of praxis through research-dominant and application-dominant configurations, their overlap, transitions between them, and the limits of treating their boundary as fixed. The method is architectural and domain-general. The section develops a GR-level landscape of praxis that can later be specialized within economics and other substantive domains without making those later specifications constitutive of the general account.

The distinction introduced here concerns the organization of praxis rather than a taxonomy of occupations, institutions, or activities. A laboratory, ministry, community organization, firm, court, school, hospital, engineering project, or household can contain both research and application functions. The same project can move between praxis modes over time, and different components of a distributed project can occupy different modes simultaneously. The analytical question is therefore which practical contradiction, orientation, responsibility structure, and closure problem currently organize the configuration most strongly.

Definition 10.1 (Praxis mode). A *praxis mode* is a historically situated and revisable configuration of knowing, judging, acting, relating, coordinating, and learning whose organization is shaped by a principal practical orientation, a characteristic contradiction, and the forms of responsibility and closure required by that orientation.

Definition 10.1 makes dominance relational and functional. It does not assign an activity an immutable identity. A project becomes intelligible as research-dominant or application-dominant according to how its heterogeneous components are organized at a given stage, scale, and level of analysis. The same observable act—measurement, modeling, consultation, experimentation, classification, communication, resource commitment, or institutional redesign—can perform different functions depending on the surrounding praxis configuration.

Table 10.1 provides a first comparison of the two modes. The table is intentionally schematic. Its purpose is to expose differences in organizing orientation while preserving their shared components and recurrent movement between them.

The shared column is as important as the contrast. Both modes involve evidence, judgment, action, uncertainty, institutions, material conditions, relations, values, temporal horizons, and feedback. Their distinction becomes analytically useful when these components are organized around different principal tasks. The remainder of the section develops that claim in greater detail.

10.1.1 Praxis as the Superordinate Category

The first task is to establish the common category within which research and application can be differentiated. Its role is to prevent the book from reproducing a linear image in which knowledge is first produced in an epistemically isolated domain and subsequently transferred into a separate domain of action. The objective is to treat inquiry and application as configurations of praxis that share constitutive elements while assigning different weights and functions to them. The discussion develops the components of praxis, the relation between orientation and activity, the signifi-

Table 10.1: Domain-general landscape of research-dominant and application-dominant praxis

Praxis dimension	Research-dominant configuration	Application-dominant configuration	Shared or coupled function
Principal orientation	Produce, test, revise, and preserve warranted knowledge	Organize consequential action under incomplete knowledge and plural practical conditions	Learning, judgment, revision, and relation to evidence
Characteristic contradiction	Need for sufficiently stable claims under incomplete and changing epistemic access	Need for sufficiently justified action while knowledge, values, consequences, and future conditions remain partly unsettled	Management of incompleteness without suspending praxis
Immediate closure problem	Determine when a claim or research cycle is sufficiently warranted for a stated purpose	Determine when an action, non-action, delay, or intervention is sufficiently justified for a stated practical horizon	Provisional closure with explicit reopening conditions
Primary consequence of error	Misdescription, weak inference, distorted explanation, lost evidence, or misleading theory	Distributed harm, foreclosed options, misallocated burdens, institutional damage, or missed opportunity in addition to epistemic error	Error propagation across knowledge and action
Role of action	Action supports inquiry and can generate epistemic access	Action constitutes a principal practical task and also generates new evidence	Intervention and observation remain mutually connected
Role of inquiry	Inquiry organizes the principal practical task	Inquiry supports diagnosis, judgment, monitoring, adaptation, and reassessment	Research persists across both modes
Responsibility emphasis	Evidential, interpretive, methodological, institutional, and field responsibility	Consequential, distributive, participatory, temporal, institutional, and epistemic responsibility	Traceability of choices and effects
Typical transition signal	Consequential choice begins to organize the project more strongly than further knowledge stabilization	Practical uncertainty, failure, novelty, or contested interpretation requires renewed epistemic work	Reassessment of the organizing contradiction

cance of principal contradiction, and the consequences of treating praxis as historically transformable.

Praxis, in the present framework, concerns situated participation in a relational field through which agents and collectives encounter conditions, form judgments, act or withhold action, experience consequences, generate records, and revise subsequent orientations. The category therefore includes epistemic activity without reducing itself to epistemology, and it includes consequential action without reducing itself to intervention. A praxis configuration can contain perception, inquiry, interpretation, classification, imagination, deliberation, coordination, implementation, maintenance, refusal, monitoring, repair, preservation, and institutionalization. Which of these functions becomes dominant depends on the practical organization of the situation.

The superordinate role of praxis also places knowing inside history. Evidence does not arrive independently of prior practices. Observation can depend on infrastructures, classifications, access relations, instruments, institutions, languages, and preserved records. Action can then modify those same conditions. A monitoring system can make some manifestations more visible. An institutional reform can change the categories through which later observations are recorded. A technical intervention can create new failure modes whose traces become the basis of subsequent inquiry. Praxis therefore contributes to the conditions under which later praxis becomes pos-

sible.

Definition 10.2 (Generative-relational praxis). *Generative-relational praxis* is historically situated participation in relational configurations through which agents and collectives form knowledge and judgment, exercise or withhold agency, transform conditions, encounter generated consequences, and revise the relations and capacities that shape later possibilities of inquiry and action.

This definition gives the category a generative dimension. Action matters partly because it changes later conditions; inquiry matters partly because it changes what can be recognized, represented, justified, and acted upon. The generated consequences can include intended outcomes, unintended effects, institutional residues, new constraints, changed capacities, altered distributions of attention, revised classifications, transformed expectations, and new practical possibilities. Some consequences become visible quickly, while others emerge across longer temporal or organizational scales.

Praxis therefore requires an account of orientation. Two projects can perform similar activities while being organized toward different practical ends. Consider a controlled intervention that alters a local condition and measures the resulting response. In one configuration, the intervention may be organized principally to discriminate among competing explanations. In another, it may be organized principally to improve a practical condition while measurement supports adaptation. The observable techniques overlap; the organizing function differs.

Orientation is also insufficient by itself when treated as declared intention. Institutions frequently contain multiple objectives, and stated missions can diverge from actual allocation of authority, resources, deadlines, and accountability. A praxis analysis therefore examines how the configuration is materially organized: which decisions receive priority, which failures trigger reconsideration, what forms of closure are demanded, who possesses authority, where consequences are borne, and what the project must deliver to count as practically successful.

The concept of a principal contradiction provides one way to interpret this organization. A principal contradiction is the tension whose management most strongly structures practical choices within the configuration at a specified stage and scale. In research-dominant praxis, the characteristic tension concerns the stabilization of warranted claims under incomplete, mediated, and revisable epistemic access. In application-dominant praxis, the characteristic tension concerns the organization of consequential action while knowledge and practical conditions remain incomplete. These formulations are analytical guides rather than claims that every project contains a single contradiction in a simple or invariant form.

Proposition 10.3 (Praxis-mode differentiation by organizing contradiction). *A distinction between research-dominant and application-dominant praxis is most informative when it tracks the contradiction, orientation, responsibility structure, and closure requirement that organize a configuration more strongly than alternative practical functions at the relevant stage and scale.*

Proposition 10.3 establishes four linked dimensions. Orientation identifies what the configuration is principally trying to accomplish. Contradiction identifies the practical tension through which that accomplishment is pursued. Responsibility identifies whose judgments and consequences require governance. Closure identifies what must become sufficiently settled for the configuration to proceed. These dimensions can align strongly, or they can diverge. A project that declares an epistemic objective

while imposing operational deadlines and irreversible commitments may already contain a growing application-dominant component. A practical programme that suspends implementation to reconstruct an uncertain mechanism may temporarily intensify its research-dominant organization.

Praxis is therefore temporally indexed. The relevant mode can change as evidence accumulates, emergencies develop, institutions alter their mandates, consequences become visible, or practical options close. It is also scale-indexed. A large programme may be application-dominant overall while containing research-dominant subprojects. A research consortium may remain research-dominant overall while one operational component carries substantial application responsibility. The superordinate category allows such nested structures to be described without forcing the entire system into one permanent label.

A further consequence concerns evaluation. If research and application are both forms of praxis, quality cannot be judged solely from outputs detached from the conditions through which they were generated. A well-estimated effect can remain practically inadequate if the action space was poorly constituted. A useful intervention can remain epistemically obscure if its mechanism and boundary conditions are unknown. A failed intervention can still produce substantial epistemic value if its traces are preserved and interpreted responsibly. A research failure can create practical harm if classifications, datasets, or models travel into consequential institutions. Praxis analysis therefore follows both epistemic and practical lineages.

This broader framing prepares the distinction developed in the next two subsections. Research-dominant praxis and application-dominant praxis are differentiated within a shared field of praxis, and their relation remains one of changing organization rather than categorical separation.

10.1.2 Research-Dominant Praxis

The second task is to restate research-dominant praxis from the perspective required by Part IV. Its role is transitional: the preceding Part developed research-dominant praxis in detail, while the present subsection identifies the features that matter for comparison with application-dominant praxis. The objective is to specify its organizing orientation, characteristic closure problem, practical consequences, and continuing presence within later application. The method is selective and synthetic, avoiding a repetition of the methodological architecture already developed.

Research-dominant praxis is organized principally around the production and revision of warranted knowledge. Its practical work can include formulating questions, constituting objects of inquiry, constructing records, selecting methods, defining variables and categories, developing interpretations, building models, comparing explanations, adjudicating evidence, preserving uncertainty, and deciding when a claim is sufficiently supported for a specified research purpose. These activities can involve extensive material and institutional action, yet their principal organization remains epistemic when the project is primarily governed by the need to improve warranted understanding.

Definition 10.4 (Research-dominant praxis). *Research-dominant praxis* is a praxis configuration in which the production, testing, revision, preservation, and provisional closure of warranted knowledge provide the principal practical orientation, while action, coordination, intervention, and institutional relations are organized

primarily in relation to that epistemic task.

The phrase “primarily in relation to” is important. Research can alter the world it studies. Fieldwork changes relations of attention and access. Experiments intentionally alter conditions. Classification changes what becomes recordable and comparable. Publication can redistribute visibility and authority. Data infrastructures influence what later researchers and institutions can encounter. Research-dominant praxis therefore carries practical responsibility even when its immediate justification is epistemic.

Its characteristic closure problem concerns sufficiency of warrant. Inquiry cannot remain indefinitely open at every level. Researchers decide when to stabilize a concept provisionally, when to accept a measurement procedure, when to privilege one model for a stated function, when to publish an interpretation, and when to close a research cycle while preserving uncertainty and conditions for reopening. The required closure remains purpose-relative. A model sufficient for exploratory comparison may remain insufficient for high-consequence prediction. A historical reconstruction sufficiently supported for one bounded claim may remain inadequate for broader causal attribution.

Research-dominant praxis also contains practical choices whose consequences can exceed the immediate epistemic task. Participant exposure, experimental burden, environmental disturbance, publication risk, resource use, access control, data governance, classification effects, and institutional reputation can all become consequential. The research orientation therefore cannot be used to discount the actual effects of research action. The distinction concerns which task organizes the configuration, while responsibility follows the effects and relations that the configuration generates.

Proposition 10.5 (Consequence-sensitive research praxis). *Research-dominant organization can coexist with substantial practical consequence; the praxis mode identifies the principal organizing task, while responsibility for generated effects remains sensitive to the scale, distribution, reversibility, and duration of those effects.*

This proposition matters for the transition into Part IV because application functions frequently emerge inside research before an explicit mode change occurs. A pilot may begin as a limited test and gradually become relied upon by participants. A classification developed for analysis may enter administrative practice. A prototype may acquire users before its governing institution has reclassified it as an operational system. A recommendation may shape behavior even while researchers continue to describe it as provisional. Such cases create a widening distance between formal research status and practical consequence.

Research-dominant praxis can respond by making the consequence pathway explicit. This includes identifying where research outputs can travel, who may act on them, what uncertainty accompanies them, what constraints apply to reuse, what harms could follow from misinterpretation, and what evidence would trigger revision. Such governance belongs to research-dominant praxis itself because the production of knowledge includes responsibility for the conditions under which that knowledge becomes available and actionable.

The distinction also clarifies why application-dominant praxis cannot be defined by the mere presence of intervention. Intervention can serve research. Observation can serve application. The mode changes when the practical organization changes: consequential action becomes a principal task whose timing, distribution, legitimacy, and generated effects can no longer be subordinated to the epistemic objective alone.

This boundary is necessarily revisable. A research project can remain strongly research-dominant across many consequential activities when those activities are tightly governed as means of inquiry. It can also move toward application-dominant praxis rapidly when external institutions begin to operationalize its outputs, when participants become dependent on an intervention, or when the decision to continue, scale, withdraw, or institutionalize the intervention becomes the dominant practical problem. The next subsection develops the configuration that emerges under those conditions.

10.1.3 Application-Dominant Praxis

The third task is to define the principal object of Chapter 10. Its role is to establish application-dominant praxis as a general GR category before later sections analyze practical situations, judgment, ends, action spaces, uncertainty, risk, power, participation, responsibility, justice, institutions, and closure. The objective is to specify what becomes distinctive when consequential action organizes praxis more strongly than further stabilization of knowledge. The method is constitutive: the subsection identifies the orientation, contradiction, consequences, and recursive learning structure that make the configuration application-dominant.

Application-dominant praxis arises when a configuration must organize action, non-action, delay, maintenance, withdrawal, repair, commitment, or institutional change in relation to practical consequences that matter independently of further inquiry. The agent or collective may possess extensive research, limited research, contested research, or rapidly changing evidence. In each case, the practical configuration requires a judgment about how to proceed while some relevant uncertainty remains.

Definition 10.6 (Application-dominant praxis). *Application-dominant praxis* is a praxis configuration in which the organization of consequential action under incomplete knowledge becomes the principal practical orientation, so that judgment, evidence, values, capacities, constraints, timing, risk, participation, responsibility, and anticipated generative consequences are coordinated around what to do within a situated practical horizon.

Definition 10.6 treats “application” broadly. The term includes implementation of established knowledge, yet it also covers situations in which knowledge is contested, emergent, locally incomplete, or transformed by the act of intervention itself. Application can concern the continuation of an existing practice, the introduction of a new one, the withholding of an available action, the repair of a damaged relation, the redesign of an institution, the preservation of a fragile condition, or the deliberate creation of time for further inquiry. The central feature is consequential practical organization.

The characteristic contradiction follows from the relation between necessity and incompleteness. Practical conditions can require action before all relevant uncertainty has been resolved. Delaying action can preserve epistemic opportunity while also generating costs, risks, or foreclosed possibilities. Acting can address an urgent condition while also creating new exposures. A choice among actions can depend on values that lack a common measure. The affected population can exceed the population that participates in the decision. Consequences can emerge on temporal and spatial scales beyond the immediate horizon of the acting institution.

Application-dominant praxis therefore changes the function of knowledge. Evidence remains indispensable, yet evidential adequacy becomes connected to a concrete action horizon. Uncertainty becomes practically distributed. A model's error is no longer only an epistemic defect when decisions rely upon it. A category boundary can affect eligibility, recognition, burden, or access. A scenario can privilege some futures by making them more governable than others. A measurement choice can shape what receives institutional attention. The passage from evidence to action is consequently itself an object of praxis analysis.

The same transformation applies to values. Practical action requires orientation toward ends, yet ends can be plural, contested, layered, and historically formed. Application-dominant praxis therefore includes normative judgment within its constitutive architecture. This does not imply that every practical choice requires a comprehensive moral theory. It implies that choices distribute consequences and presuppose criteria of relevance, acceptability, priority, protection, or obligation. Those criteria should be made as visible and contestable as the practical situation permits.

Application also has a generative dimension. An intervention changes more than an immediate output when it alters capacities, dependencies, institutions, expectations, categories, relations of trust, future action spaces, or conditions of evidence production. A short-term success can generate a long-term constraint. A costly intervention can create new capacities that later reduce dependence. A reversible pilot can generate information and institutional learning. A seemingly minor procedural change can redistribute voice or visibility. The practical object therefore includes trajectories and generated conditions, not only terminal outcomes.

Proposition 10.7 (Generative consequence of application). *Application-dominant praxis should evaluate consequential action partly through the relational and generative conditions it creates for later action, inquiry, participation, capacity, constraint, and revision, in addition to the immediate outcomes used to justify the action.*

The proposition expands the temporal horizon of practical evaluation while preserving scope discipline. Some decisions can reasonably be assessed through relatively immediate outcomes. Others materially transform future possibility structures. The analytical burden should scale with the plausible depth, duration, and distribution of those transformations. The framework therefore supports differentiated levels of practical analysis rather than requiring exhaustive reconstruction for every ordinary action.

Application-dominant praxis also contains inquiry as an internal function. Diagnosis precedes and accompanies action. Monitoring observes generated consequences. Failure can reveal mistaken assumptions. Implementation can expose institutional constraints that were absent from prior models. Participation can disclose values, experiences, or dependencies that formal analysis did not capture. New manifestations can require revised categories. Application can therefore become a site of epistemic generation without ceasing to be application-dominant.

Definition 10.8 (Action-learning recursion). *An action-learning recursion is a practical sequence in which situated action generates consequences and manifestations that are interpreted as evidence for revising diagnosis, judgment, intervention, institutional arrangement, or the governing representation of the practical situation.*

The recursion is central to the chapter's later architecture. It explains why application-dominant praxis requires monitoring, traceability, reversibility where

feasible, institutional memory, and explicit conditions for reassessment. A practical decision can be provisional even when action must be immediate. Provisionality refers to openness to governed revision rather than hesitation about acting.

The concept also clarifies why practical success and epistemic success can diverge. An intervention can produce a desirable local outcome through a mechanism that remains poorly understood. A well-supported mechanism can produce disappointing results because the practical situation contained unmodeled constraints. A programme can meet its declared target while generating harmful relational effects outside the metric. Application-dominant praxis therefore needs multiple forms of evaluation and a capacity to reconsider the practical situation itself.

This domain-general account leaves substantive specification open. Later parts of the book can examine how application-dominant praxis changes when the relevant objects are economic resources, institutions, value forms, allocation structures, power relations, or economic capacities. Other domains can specify different materials, authorities, risks, and norms. The general category established here provides the landscape within which those differences can become analytically explicit.

10.1.4 Overlap between Praxis Modes

The fourth task is to describe the shared interior of research-dominant and application-dominant praxis. Its role is to prevent the distinction from becoming a binary division that assigns inquiry to one side and action to the other. The objective is to identify functions that recur across both modes and to explain how their practical meaning changes with the surrounding organization. The discussion considers inquiry within application, action within research, hybrid configurations, nested modes, and the consequences of distributed agency.

Both modes contain inquiry. Research-dominant praxis places inquiry at the center of the practical configuration, whereas application-dominant praxis uses inquiry to constitute the situation, assess options, anticipate consequences, monitor effects, and revise action. The difference therefore concerns the function of inquiry within the configuration. In application-dominant praxis, the question “what can be warranted?” remains present, while the configuration also requires judgments about what to do before every uncertainty is resolved.

Both modes also contain action. Research requires the construction of records, the use of instruments, engagement with participants, allocation of resources, design of studies, maintenance of infrastructures, and decisions about publication and preservation. These acts can change the relational field. Application places consequential transformation more centrally, yet its interventions can also be designed to preserve epistemic access and enable learning. The same project can therefore combine strong inquiry and strong intervention intensity.

Definition 10.9 (Praxis-mode overlap). *Praxis-mode overlap* is the coexistence of research and application functions within a shared configuration, where the presence of both functions remains compatible with identifying one mode as dominant when its organizing contradiction and practical closure problem structure the configuration more strongly.

Overlap can take several forms. The first is *functional overlap*: the same act serves both epistemic and practical purposes. A pilot can improve a condition while producing evidence about feasibility. Monitoring can protect affected subjects while gener-

ating data. Consultation can support legitimacy while revealing previously unrecognized causal relations. A model can guide a decision while exposing uncertainty that motivates new research.

The second is *temporal overlap*. A programme can contain research and application processes unfolding on different clocks. Operational teams may act daily while a research team updates models monthly. Community participants may encounter consequences immediately while institutional evaluation occurs later. Short-run application can therefore coexist with longer-run research-dominant inquiry.

The third is *organizational overlap*. Distinct institutions or teams can occupy different praxis modes while contributing to one distributed project. A research unit can estimate mechanisms, an operational unit can implement interventions, a regulatory body can authorize action, and affected communities can generate situated knowledge and contest practical assumptions. The overall configuration cannot be understood adequately by assigning the entire network a single institutional identity.

The fourth is *scale overlap*. A local component may be research-dominant while the larger programme is application-dominant, or the reverse. An organization testing a small procedural variation may conduct a research-dominant subproject inside a mature service system. A research consortium can operate an application-dominant safety or support function whose success is practically required irrespective of the research outcome. Scale-sensitive analysis therefore matters whenever responsibility, authority, and consequence are distributed unevenly.

Proposition 10.10 (Co-presence without mode collapse). *The coexistence of substantial research and application functions does not by itself eliminate praxis-mode differentiation; differentiation remains informative when one organizing contradiction, responsibility structure, and closure requirement is sufficiently dominant at the specified stage and scale.*

This proposition allows hybrid configurations to be described without assuming that every overlap produces an analytically indeterminate case. At the same time, the dominance claim should remain revisable. If authority, resource allocation, success criteria, or practical consequences shift, the mode assessment can change.

Overlap also creates distinctive governance demands. An intervention designed partly for learning can expose participants to risks that arise from experimentation. An operational programme that simultaneously produces research data can create consent, access, ownership, or representation questions. A research activity embedded in a service institution can be difficult for affected subjects to distinguish from ordinary service provision. A project can therefore require mode-specific governance within a shared organizational setting.

A further issue concerns success criteria. Research-dominant success can include improved discrimination among explanations, stronger measurement, productive falsification, discovery of uncertainty, or generation of a better question. Application-dominant success can include acceptable practical improvement, prevented harm, preserved options, enhanced capacity, or legitimate coordination. A hybrid project may satisfy one criterion while failing another. Praxis-mode overlap therefore benefits from separate but connected evaluation records rather than a single composite score that obscures the difference.

The overlap also matters for learning from failure. A practically unsuccessful intervention can generate valuable knowledge. That epistemic value does not erase the

practical loss, especially where burdens were distributed unequally. Conversely, a practically useful intervention can generate weak knowledge if attribution remains uncertain. The framework can preserve both evaluations simultaneously. Such double accounting is important for a generative-relational approach because later action can depend on both what happened and what has actually been learned from what happened.

These overlapping structures make transitions between praxis modes common rather than exceptional. Once inquiry and application are understood as co-present functions, the next question concerns how their relative organization changes over time.

10.1.5 Transformation between Praxis Modes

The fifth task is to theorize movement between praxis modes. Its role is to replace a one-way research-to-application pipeline with a reversible and recursively governed account of practical transformation. The objective is to identify transition signals, distinguish gradual from abrupt mode change, preserve continuity of records and responsibility, and explain how a configuration can return toward research-dominant organization after consequential action has begun. The method is process-oriented and scale-sensitive.

A mode transition occurs when the relative organization of praxis changes. The activities present before and after the transition can remain partly continuous. Researchers may continue collecting data after an intervention becomes operational. Practitioners may continue implementing a programme while suspending one component for intensive inquiry. What changes is the practical hierarchy among tasks, the authority attached to decisions, the urgency of closure, and the consequences attached to error.

Definition 10.11 (Praxis-mode transition). A *praxis-mode transition* is a change in the dominant organization of a praxis configuration through which another practical orientation, contradiction, responsibility structure, or closure requirement becomes sufficiently determinative to reorganize how evidence, judgment, action, authority, resources, and revision are coordinated.

Transitions can be gradual. A prototype can acquire users, dependencies, and institutional commitments over time. A pilot can expand in scale until withdrawal becomes materially costly. A research recommendation can be incorporated incrementally into operating procedures. A dataset can become infrastructural for decisions. In such cases the mode can shift before any formal declaration of “implementation” occurs.

Transitions can also be abrupt. An emergency can convert an exploratory research setting into a practical decision environment. Discovery of an immediate hazard can create a responsibility to act. A regulatory authorization can move a technology into operational use. A sudden institutional decision can require a research team to provide decision support before its preferred research cycle has closed. Abrupt transitions compress the time available for reassessing uncertainty, responsibility, and governance.

Several signals can indicate movement toward application-dominant praxis. Consequential outcomes may become direct performance criteria. Affected subjects may begin to depend on continuation of the intervention. Withdrawal can acquire its own

risks. Decisions about scale, access, eligibility, timing, or allocation can become more important than further epistemic refinement. Operational deadlines can constrain inquiry. Authority can shift from investigators toward institutions responsible for implementation. Error can begin to carry consequences whose distribution requires explicit practical governance.

Movement in the other direction is equally important. An intervention may expose a poorly understood mechanism. Monitoring may reveal unexpected heterogeneity. A practical failure may undermine the representation on which the decision was based. New affected subjects may become visible. A contested value assumption may destabilize the initial problem formulation. Under such conditions, application-dominant praxis can intensify research functions or temporarily return a component of the project to research-dominant organization.

Proposition 10.12 (Reversible orientation of praxis transitions). *Praxis-mode transitions can proceed in either direction and can recur within the same project; the appropriate direction depends on changes in the practical contradiction, available knowledge, generated consequences, institutional conditions, and responsibility structure rather than on a presumed developmental sequence from research toward application.*

This proposition is important because the familiar image of research followed by application encourages premature closure. Once an intervention has been classified as “implemented,” organizations can become reluctant to reopen foundational questions. A recursive praxis architecture keeps re-epistemization available when practical experience reveals that prior knowledge, categories, or assumptions require reconstruction.

Transitions also require continuity of records. Evidence, uncertainty, assumptions, affected populations, decision rationales, authorization structures, anticipated consequences, and reopening conditions should travel across the transition where materially relevant. Otherwise application can inherit decontextualized research outputs, while renewed research can lose the practical history through which anomalies emerged. The practical meaning of a record can change across modes, yet its lineage remains important.

Definition 10.13 (Praxis-transition record). *A praxis-transition record is a revisable account of the evidence, uncertainty, assumptions, values, authority, affected relations, responsibilities, anticipated consequences, and reopening conditions that accompany a change in the dominant organization of praxis.*

A transition record does not need to be bureaucratically elaborate in every setting. Its form should scale with consequence, institutional complexity, uncertainty, duration, and reversibility. In a high-consequence system, the record may require formal governance and extensive traceability. In an ordinary local decision, a simpler articulation of assumptions, responsibilities, and revision conditions may be sufficient. The underlying principle is continuity of practical intelligibility.

Mode transition can also be asymmetric across actors. A research team may still understand a project as experimental while an affected community experiences it as an operational intervention. A regulator may treat a system as deployed while developers continue to treat it as a prototype. A public institution may adopt a model as decision support while model builders describe it as exploratory. Such asymmetry matters because responsibilities cannot be allocated reliably from one actor’s self-description alone.

Proposition 10.14 (Transition assessment through distributed consequence). *Assessment of a praxis-mode transition should include how relevant actors and affected subjects encounter the configuration, because operational dependence, exposure, authority, and practical consequence can shift before the initiating organization formally reclassifies its activity.*

This distributed perspective prepares later analysis of participation, responsibility, and justice. It also shows why the research–application distinction is analytically useful only when treated as a dynamic relation. The final subsection therefore turns to the limits of fixed boundaries and specifies how the distinction can be retained without reifying it.

10.1.6 Limits of Fixed Research–Application Boundaries

The final task is to delimit the distinction developed in this section. Its role is to prevent research-dominant and application-dominant praxis from becoming rigid ontological categories, institutional stereotypes, or universal stage sequences. The objective is to state the conditions under which the distinction remains useful, identify characteristic boundary failures, and formulate the open transition into the principal contradiction of application-dominant praxis. The method is reflexive: the analytical categories are subjected to the same requirements of scope, revisability, and historical sensitivity that the broader framework applies to other representations.

A fixed boundary can fail first by institutional substitution. Universities, laboratories, firms, governments, non-governmental organizations, communities, courts, hospitals, and international institutions cannot be assigned a praxis mode from institutional identity alone. Each can conduct inquiry, intervention, governance, experimentation, preservation, or service. The relevant configuration must be reconstructed from actual orientation, authority, consequence, and closure requirements.

A fixed boundary can also fail by occupational substitution. “Researcher” and “practitioner” are roles with real institutional significance, yet they do not exhaust the praxis functions performed by the people who occupy them. Practitioners generate situated knowledge. Researchers make consequential decisions. Participants can become co-investigators. Technical operators can discover mechanisms through maintenance. Communities can develop practical theories through long experience. Praxis analysis therefore follows functions and relations in addition to formal roles.

A third failure arises from temporal staging. The sequence research, application, evaluation, and renewed research can be useful for planning, yet many configurations operate recursively. Diagnosis continues during implementation. Intervention generates evidence. Evaluation changes the intervention before a nominal end point. Practical urgency can initiate action while research remains active. Long-term operation can uncover conditions that return the project to foundational inquiry. A fixed stage model can obscure these recursions.

A fourth failure concerns scale. The dominant mode at one level can differ from the dominant mode at another. A research-dominant organization may operate an application-dominant infrastructure. An application-dominant public programme may contain research-dominant trials. A collective can pursue an application-dominant objective while one subgroup undertakes epistemic reconstruction. The appropriate classification therefore depends on the analytical unit.

A fifth failure arises from power over classification. Organizations can benefit

from describing an activity as research when that description reduces practical accountability, or as application when it discourages reopening epistemic assumptions. Formal labels can therefore become strategically consequential. Praxis-mode analysis should examine who has authority to classify the activity, what obligations follow from that classification, and how affected subjects experience the actual consequences.

Definition 10.15 (Praxis-boundary profile). A *praxis-boundary profile* is a stage- and scale-specific account of the orientation, principal contradiction, inquiry functions, application functions, authority relations, consequence structure, closure requirements, and plausible transition signals through which a praxis configuration is provisionally characterized.

The profile formulation preserves analytical usefulness while avoiding categorical rigidity. It allows a project to be described as strongly research-dominant, strongly application-dominant, mixed with one dominant orientation, locally divergent across subcomponents, or temporarily indeterminate when the organizing structure is genuinely unstable. Indeterminacy can itself be informative when responsibility structures are changing faster than institutional classifications.

Proposition 10.16 (Provisionality of praxis-mode classification). A *praxis-mode classification should be treated as a provisional analytical judgment indexed to stage, scale, actors, and consequence, and should be reopened when changes in orientation, authority, dependence, uncertainty, or practical effect materially alter the configuration.*

This principle also limits the theoretical ambition of Chapter 10. The chapter does not require every form of human or institutional activity to be reduced to two modes. Research-dominant and application-dominant praxis are tools for analyzing an important family of configurations in which inquiry and consequential action interact. Other distinctions can become necessary for different problems. The present framework remains open to such extension.

The boundary limitation does not diminish the importance of application-dominant praxis. It sharpens the concept by locating its function. The category becomes most useful when practical consequence has become sufficiently central that evidence, uncertainty, values, timing, risk, authority, participation, and responsibility must be coordinated around a decision about what to do. Once that condition is present, the characteristic contradiction of application-dominant praxis becomes visible.

Proposition 10.17 (Application-dominant entry condition). *Application-dominant analysis becomes especially important when consequential choice has acquired sufficient practical weight that further inquiry alone cannot discharge the responsibilities created by action, non-action, delay, commitment, withdrawal, or institutional continuation.*

Proposition 10.17 establishes the transition to the next section. The principal problem is now more specific than the general distinction between praxis modes. Once action becomes practically determinative, a configuration must act with knowledge that remains partial, values that may remain plural, consequences that can be distributed unequally, and temporal conditions that can constrain revision. Section 10.2 therefore develops the principal contradiction of application-dominant praxis: the organization of necessary or consequential action under epistemic incompleteness, uncertainty, normative commitment, plural value, urgency, and possible irreversibility.

10.2 The Principal Contradiction of Application-Dominant Praxis

Section 10.1 established application-dominant praxis as a provisional configuration in which consequential choice and intervention organize the practical field. The present section identifies the characteristic tension that becomes especially important within that configuration. Its objective is to specify why consequential action can become practically required while the epistemic, normative, temporal, and institutional conditions of action remain incomplete or contested. The discussion proceeds through necessity of action, incomplete knowledge, uncertainty, normative commitment, value plurality, urgency, irreversibility, and transformation of the contradiction. The method is conceptual and relational: each dimension is treated as part of a changing practical configuration rather than as an isolated obstacle to otherwise complete decision-making.

The term *principal contradiction* is used here in a restricted analytical sense. It identifies a tension that can become organizing for a praxis configuration because multiple practical demands must be coordinated through it. The term does not imply that every concrete situation has one exhaustive contradiction, that secondary tensions cease to matter, or that practical history follows a predetermined dialectical sequence. A principal contradiction can change with scale, stage, actor, institutional location, and consequence. Its analytical value lies in identifying what currently organizes the difficulty of acting.

Definition 10.18 (Principal contradiction of application-dominant praxis). The *principal contradiction of application-dominant praxis* is the recurrent tension between the practical requirement to organize consequential action and the incompleteness of the epistemic, normative, temporal, and institutional conditions through which that action can be justified, coordinated, revised, and borne.

Table 10.2: Dimensions of the principal contradiction in application-dominant praxis.

Dimension	Practical pressure	Residual openness
Action	Consequences accumulate through action, non-action, continuation, or delay.	Multiple feasible orientations can remain available.
Knowledge	Decisions require some account of conditions, mechanisms, and consequences.	Evidence and models remain partial, mediated, and revisable.
Uncertainty	Choice must proceed with possible divergence between expectation and realization.	Probabilities, mechanisms, or relevant possibilities can remain incompletely specified.
Normativity	Action distributes benefits, burdens, exposure, capacities, and opportunities.	Legitimate ends and acceptable trade-offs can remain contested.
Value plurality	Several goods, commitments, or evaluative registers can bear on one decision.	Conversion among values can be partial, disputed, or context-dependent.
Time	Deliberation occurs within changing conditions and practical deadlines.	Additional inquiry can improve understanding while delay changes the field.
Reversibility	Decisions can commit resources, institutions, relations, or trajectories.	Future correction can range from inexpensive revision to severe path dependence.

The definition contains two interacting poles. The first is practical determination: a configuration reaches a point at which action, non-action, delay, withdrawal, continuation, or commitment has consequences that require judgment. The second is conditional incompleteness: the knowledge required for prediction can remain partial, values can remain plural, authority can be distributed, timing can compress deliberation, and consequences can exceed the reversibility of the decision. Application-dominant praxis therefore develops through the organization of action within residual incompleteness.

This formulation also clarifies why the contradiction cannot be reduced to uncertainty alone. A technically well-estimated probability distribution can coexist with disagreement about acceptable risk, unequal exposure to loss, contested authority, and incompatible values. Conversely, a normative consensus can coexist with profound uncertainty about causal mechanisms. The practical difficulty emerges from the joint configuration of these dimensions.

Table 10.2 summarizes the configuration developed below. The paired columns are intentionally relational. Practical pressure and residual openness are not separate lists of problems. Each pressure acquires meaning through the openness that accompanies it, while each form of openness becomes practically significant because consequential choice remains present. The principal contradiction is therefore a structure of co-presence.

10.2.1 Necessity of Action

The first dimension concerns the conditions under which action acquires practical necessity. The term *necessity* requires careful qualification. Application-dominant praxis frequently contains several available responses, including waiting, continuation, withdrawal, delegation, experimentation, or deliberate non-intervention. Necessity therefore does not ordinarily mean that one uniquely determined act follows from the situation. It means that the configuration has reached a point at which the practical consequences of choosing, deferring, continuing, or refusing can no longer be treated as external to the responsible organization of praxis.

A practical field can acquire this character through many pathways. Material deterioration may continue during deliberation. Existing institutions may reproduce burdens through routine operation. A time-limited opportunity may close. An affected population may already be exposed to ongoing harm. A technical system may require maintenance decisions. An organization may need to allocate finite attention or resources. A collective commitment may reach an implementation stage. In each case, practical consequence accumulates through temporal passage and existing relations, even before a new intervention is selected.

Definition 10.19 (Practical necessity). *Practical necessity* is a condition in which the consequences of action, non-action, delay, continuation, or withdrawal have become sufficiently salient that responsible praxis requires an explicit practical orientation within the relevant horizon.

This definition separates practical necessity from deterministic compulsion. An actor can remain uncertain about what to do while still facing a practical requirement to organize a response. The relevant object is the relation between consequence and responsibility. When the field continues to evolve, a refusal to select an intervention can itself preserve existing mechanisms, shift burdens through delay, or allow opportunities to disappear. The practical configuration therefore contains an active temporal structure.

Necessity is also scale-sensitive. A situation can be urgent for one actor and comparatively stable for another. A decision that appears deferrable at an organizational level can already be consequential at the level of households, ecosystems, communities, patients, infrastructures, or workers. Conversely, a local actor can experience immediate pressure while a wider institutional system requires slower coordination to avoid transferring risk elsewhere. Application-dominant analysis therefore asks whose horizon supplies the practical clock and whose consequences establish the significance of delay.

The concept also has an institutional dimension. Formal mandates can create decision deadlines, yet institutional deadlines do not exhaust practical necessity. A statutory timetable, contractual obligation, budget cycle, or operational schedule can organize action even when the underlying human or ecological situation changes at a different pace. Equally, severe practical necessity can arise without formal recognition. The distinction between institutional time and experienced consequence becomes important when the two diverge.

Proposition 10.20 (Consequential continuity). *When relevant relations continue to generate material, institutional, social, ecological, or other practical consequences during deliberation, the passage of time forms part of the action field and should be included in the assessment of practical necessity.*

Proposition 10.20 prevents a common abstraction in which deliberation is represented as occurring outside the world it seeks to govern. Application-dominant praxis unfolds inside ongoing processes. Inquiry consumes time. Consultation consumes time. Coordination consumes time. Delay may preserve options in one domain while closing them in another. A practical theory therefore needs to represent temporal passage as part of the situation itself.

Practical necessity can also be generated endogenously by prior commitments. Earlier decisions may create dependencies, expectations, infrastructures, or obligations that make later decisions harder to avoid. An experimental intervention can generate a population that depends on continued support. A temporary institution can become embedded in a wider system. A technological standard can induce complementary investments. A practical configuration consequently inherits the generative effects of its own history.

The recognition of necessity does not settle the substantive decision. It identifies why application-dominant praxis cannot wait for epistemic completion as a general precondition of action. The next subsection therefore turns to the incomplete knowledge with which practical necessity must be coordinated.

10.2.2 Incomplete Knowledge

Incomplete knowledge is a structural condition of application-dominant praxis because practical decisions concern open relational configurations whose future development cannot ordinarily be exhausted by current observation. Parts II and III developed the epistemic architecture through which manifestation, evidence, representation, inference, modeling, and research closure remain partial and revisable. Application-dominant praxis inherits that architecture while adding practical consequence. The question becomes how epistemic incompleteness should enter judgment when decisions can no longer be postponed solely for the sake of further inquiry.

Knowledge can be incomplete in several distinct senses. Relevant entities or relations may remain unobserved. Observations may be available but noisy, delayed, selectively recorded, or institutionally filtered. Mechanisms may be contested. Models may omit important interactions. Parameter estimates may be unstable across contexts. Historical analogies may have limited transferability. Affected subjects may possess situated knowledge that has not entered formal evidence systems. Future conditions can change the transformation rules on which present predictions depend.

These forms of incompleteness should be kept analytically distinct because they support different responses. Missing data can motivate additional measurement. Model uncertainty can motivate comparison across representations. Mechanism uncertainty can motivate causal investigation or controlled variation where feasible. Unrecognized experience can motivate participation and epistemic widening. Structural change can motivate adaptive monitoring. Application-dominant praxis benefits from diagnosing the form of incompleteness before selecting a practical response to it.

Definition 10.21 (Decision-relevant epistemic incompleteness). *Decision-relevant epistemic incompleteness* is the residual uncertainty, omission, ambiguity, disagreement, or model dependence that can materially alter the interpretation of available actions, anticipated consequences, affected relations, or revision conditions within a practical horizon.

The definition narrows attention to incompleteness that can matter for practical judgment. Complete knowledge is unavailable in most real settings, while much missing information has little bearing on the present decision. The relevant question is therefore selective: which uncertainties could reasonably change what is considered permissible, robust, proportionate, reversible, urgent, or worthy of further inquiry?

This selection itself is fallible. What appears practically irrelevant can later prove important because the relational field changes or because previously marginalized effects become visible. For that reason, practical sufficiency should remain revisable. An evidence threshold can support action at one stage while reopening when new consequences emerge.

Proposition 10.22 (Provisional practical sufficiency). *Application-dominant praxis can treat knowledge as provisionally sufficient for a bounded decision while retaining explicit residual uncertainty, scope conditions, monitoring requirements, and reopening criteria.*

The proposition establishes a middle position between indefinite inquiry and epistemic overclosure. Provisional sufficiency means that available knowledge supports a particular practical commitment under specified conditions. It does not convert partial knowledge into certainty. The distinction is especially important for high-consequence decisions because the pressure to act can encourage institutional language that suppresses residual uncertainty once authorization has been granted.

Incomplete knowledge also interacts with power. Some uncertainties are visible because institutions possess instruments for measuring them; others remain obscure because affected relations fall outside established categories or data systems. The absence of evidence can therefore reflect both epistemic difficulty and institutional history. Later sections on power and participation will develop this issue directly. At this stage, the implication is that epistemic incompleteness has a relational distribution: different actors know different things, possess different capacities to make knowledge legible, and bear different consequences when uncertainty is resolved incorrectly.

Application-dominant praxis consequently requires a representation of knowledge that remains attached to provenance, uncertainty, disagreement, and scope. Research outputs entering an action field should carry their epistemic conditions with them. A point estimate separated from its assumptions, a model output separated from its training or observation domain, or an expert recommendation separated from dissent can acquire unwarranted practical authority. The transition from research to application therefore changes the consequences of epistemic compression.

Incomplete knowledge becomes practically acute when choice must proceed among alternatives whose consequences remain partly unresolved. This leads directly to decision under uncertainty.

10.2.3 Decision under Uncertainty

Uncertainty describes the practical openness that remains after available knowledge has been organized. Its role in application-dominant praxis is broader than statistical uncertainty. Some uncertainties can be represented probabilistically; others concern model structure, causal interpretation, institutional response, value change, strategic interaction, unanticipated events, or the appearance of possibilities that are absent

from the current action model. A general theory of praxis therefore needs a layered conception of uncertainty.

Decision under uncertainty begins with an asymmetry between anticipation and realization. Action is selected through representations of possible futures, while consequences unfold in a relational field that exceeds those representations. The gap can be small in highly controlled settings and substantial in open systems. Practical judgment should therefore attend both to expected consequence and to the architecture through which surprise can be detected and absorbed.

A useful distinction separates *estimable uncertainty* from *structural openness*. Estimable uncertainty concerns variation that can be represented through a sufficiently stable model or empirical distribution. Structural openness concerns changes in relations, categories, mechanisms, actors, institutions, or environmental conditions that can alter the relevance of the model itself. The distinction is analytical rather than absolute; practical situations can move between the two as evidence accumulates or the system changes.

Definition 10.23 (Practical uncertainty). *Practical uncertainty* is the decision-relevant openness between anticipated and realized consequences, including uncertainty about observations, parameters, mechanisms, models, interactions, values, institutions, and possible future configurations.

This definition supports several responses that will be developed more fully in Chapters 10 and 11. Praxis can preserve options, stage commitments, diversify interventions, use reversible pilots, establish monitoring, define stopping rules, maintain contingency capacity, or select actions that remain acceptable across several plausible representations. These strategies respond to different forms of uncertainty and should therefore be chosen through diagnosis rather than through a universal template.

Uncertainty also alters the meaning of evidence. In research-dominant praxis, unresolved uncertainty can motivate continued inquiry as the principal response. In application-dominant praxis, the same uncertainty enters a decision architecture that must weigh the consequences of acting, waiting, and learning. Additional information has practical value only in relation to the time, cost, reversibility, and consequence structure of the decision.

Proposition 10.24 (Uncertainty-sensitive action). *When consequential action proceeds under residual uncertainty, the practical design of the action should reflect the form, distribution, and potential consequence of that uncertainty through appropriate degrees of reversibility, monitoring, redundancy, contestability, and capacity for revision.*

Proposition 10.24 shifts uncertainty from a descriptive appendix into the architecture of action. A claim that a decision is uncertain has limited practical content unless the design of the intervention changes accordingly. High uncertainty combined with high irreversibility can justify a different practical configuration from high uncertainty combined with inexpensive reversibility. Likewise, uncertainty borne predominantly by actors who lack decision power raises questions that extend beyond technical risk estimation.

Decision under uncertainty therefore already touches normative commitment. Choosing an action under uncertainty means deciding which possibilities count, which harms warrant protection, which benefits justify exposure, and who may legit-

imately bear residual risk. The next subsection develops this normative dimension directly.

10.2.4 Normative Commitment

Application-dominant praxis contains normative commitment because consequential action changes conditions that matter to subjects, institutions, communities, or other valued entities. Even when a practical task is framed in technical language, decisions about objectives, thresholds, acceptable error, burden distribution, priority, and continuation embed evaluative commitments. The analytical task is to make those commitments sufficiently visible for judgment, contestation, and revision.

Normative commitment can enter praxis through explicit goals, legal obligations, professional duties, organizational missions, social expectations, ethical principles, cultural practices, or tacit assumptions about what counts as improvement. These sources can reinforce one another or conflict. Their practical force also varies across actors. A statutory obligation may bind an institution even when individual participants disagree with its underlying value. A community norm may carry substantial legitimacy locally while remaining absent from formal policy documents.

The presence of normative commitment does not imply that practical reasoning reduces to moral theory. Application-dominant praxis also contains empirical, technical, institutional, and strategic questions. The key point is that these dimensions interact. A causal model can estimate possible consequences, yet the decision to privilege one consequence over another requires evaluative judgment. A cost estimate can describe resource requirements, yet the acceptability of distributing costs across groups remains normative. A prediction can describe likely behavior, yet the decision to design around that behavior can raise questions of autonomy, fairness, or responsibility.

Definition 10.25 (Normative commitment in praxis). *A normative commitment in praxis is an explicit or implicit evaluative orientation that influences which conditions are treated as desirable, acceptable, protectable, compensable, urgent, or worthy of transformation within a practical configuration.*

The definition is intentionally broad because normative content can enter far upstream of final choice. Problem formulation can privilege some harms. Measurement systems can operationalize particular values. Eligibility criteria can define whose needs count. Optimization objectives can formalize selected ends. Monitoring indicators can determine what becomes visible after implementation. Practical judgment therefore benefits from tracing normative commitments through the entire action architecture.

Normative commitment also creates responsibility for justification. The stronger the consequences imposed on others, the greater the practical importance of explaining which values were used, how conflicts were handled, whose interests were represented, and what conditions would justify revision. This requirement can be institutionalized through public reasoning, participation, review, appeal, or independent oversight, depending on the scale and character of the intervention.

Proposition 10.26 (Normative traceability). *When practical decisions materially affect others, the evaluative commitments that shape objectives, thresholds, trade-offs, and revision conditions should remain sufficiently traceable for relevant forms of justification, contestation, and accountability.*

Normative traceability does not require a single comprehensive moral doctrine shared by all participants. In plural settings, practical legitimacy may depend on procedures for negotiating partially incompatible commitments, protecting certain constraints, identifying areas of overlap, and preserving contestability where consensus is unavailable. The resulting architecture can remain provisional.

This leads to value plurality. Application-dominant praxis often contains several forms of value whose relations are only partially commensurable. Treating normative commitment as singular would therefore oversimplify the practical field.

10.2.5 Plural Values

Value plurality concerns the coexistence of several evaluative registers within one practical situation. Safety, autonomy, equality, continuity, dignity, ecological integrity, efficiency, cultural meaning, learning, resilience, procedural legitimacy, and future option value can all become relevant without sharing a common unit. The specific values vary by domain and history; the general problem is that practical choice can require coordination across evaluative differences that resist complete conversion.

A plural-value perspective has two implications. First, disagreement need not indicate a simple information deficit. Actors can agree on facts and still prefer different practical orientations because they assign different significance to consequences. Second, aggregation procedures can transform the problem. Converting multiple values into a common score, price, ranking, or objective function can be useful for selected decisions, yet the conversion itself introduces assumptions about weights, substitutability, thresholds, and admissible loss.

This chapter remains domain-general, so it does not attempt to settle a substantive theory of value. Its task is structural: application-dominant praxis should be able to represent the presence of heterogeneous values, partial commensurability, and contested conversion without forcing premature synthesis.

Definition 10.27 (Plural practical value). *Plural practical value* refers to a configuration in which several evaluative registers bear materially on practical judgment and cannot be presumed in advance to admit complete, stable, or uncontested conversion into a single ordering.

The phrase *cannot be presumed in advance* is important. Some practical situations do support workable common metrics for bounded purposes. Others require threshold rules, side constraints, lexical priorities, deliberative comparison, multi-criteria reasoning, or preservation of disagreement. The appropriate architecture depends on the relation among values and on the consequences of conversion.

Value plurality also has a temporal dimension. Present actors can value future flexibility, cultural continuity, institutional trust, learning capacity, or ecological persistence in ways that compete with immediate gains. Future affected subjects cannot always participate directly in current decisions. Application-dominant praxis therefore encounters values across unequal temporal positions as well as across contemporaneous actors.

Proposition 10.28 (Value-conversion visibility). *When heterogeneous values are converted into a common practical ordering, the conversion rules, exclusions, weights, thresholds, and residual disagreements should remain visible to the degree that they can materially affect consequence or legitimacy.*

Proposition 10.28 prepares later GRE analysis without making Chapter 10 economics-specific. Conversion is a general practical operation. A committee can convert different forms of evidence into a recommendation; a court can relate competing rights; a hospital can prioritize care under capacity constraints; an environmental authority can compare immediate livelihood effects with long-horizon ecological consequences. The specific substantive theories differ, while the structural issue of conversion recurs.

Plurality also changes the meaning of optimization. An action that is optimal under one evaluative representation can be unacceptable under another. Application-dominant praxis therefore benefits from identifying where optimization is locally valid and where practical judgment must preserve multiple constraints or unresolved values. Chapter 11 will return to this methodological implication.

Value plurality becomes especially difficult when time for deliberation contracts. Urgency can reduce the practical space for evidence gathering, participation, negotiation, and institutional review. It can also create incentives to suppress disagreement in the name of speed. The next subsection examines this temporal pressure.

10.2.6 Urgency

Urgency describes a relation between changing conditions and the time available for practical response. It is therefore more than subjective pressure or organizational haste. A situation becomes urgent when relevant consequences, opportunities, capacities, or constraints can change materially within the period required for inquiry and coordination. Urgency can arise gradually, suddenly, or through accumulation that becomes visible only after thresholds are crossed.

A relational account distinguishes several sources of urgency. Harm can accelerate. A window for prevention can narrow. A temporary resource can expire. A cascading process can amplify delay. Institutional legitimacy can deteriorate. A conflict can intensify. Seasonal, ecological, technical, legal, or biological cycles can impose deadlines. In other cases, urgency is produced institutionally through budgets, electoral calendars, contractual terms, reporting cycles, or managerial targets. These different sources should not be treated as interchangeable because their flexibility and legitimacy differ.

Definition 10.29 (Practical urgency). *Practical urgency* is a condition in which the expected practical consequences of temporal delay become sufficiently significant that the available period for inquiry, deliberation, coordination, or staged intervention is materially constrained.

Urgency compresses the relation between research and application. Under generous time conditions, uncertainty can motivate additional inquiry before commitment. Under compressed conditions, inquiry may need to continue during action. This increases the importance of adaptive design, distributed observation, explicit uncertainty, contingency capacity, and revision mechanisms. A decision architecture suitable for a stable environment can become fragile when used under rapidly changing conditions.

Urgency should also be assessed distributively. The same delay can impose severe costs on one group while giving another group valuable time for learning or preparation. A decision framed as urgent from the perspective of an institution can transfer risk to actors who receive little opportunity to participate. Conversely, lengthy proce-

dures can protect formal process while allowing material harm to accumulate among people with less institutional voice. Practical urgency therefore cannot be inferred solely from the timetable of the most powerful decision-maker.

Proposition 10.30 (Distributed temporal assessment). *Assessment of urgency should include the temporal consequences of action and delay across materially affected actors, relations, and scales, because practical time can be distributed unevenly within the same configuration.*

The proposition also helps distinguish urgency from manufactured haste. Institutions can compress deadlines through prior inaction, strategic framing, resource withdrawal, or avoidable planning failures. Once a deadline becomes real, its historical origin still matters for responsibility and for redesigning future praxis. A generative-relational account therefore examines both present temporal constraint and the processes that produced it.

Urgency interacts strongly with epistemic incompleteness. Less time can reduce measurement, consultation, model comparison, and review. At the same time, urgent situations can produce new information rapidly because consequences become observable. The resulting praxis benefits from short learning cycles and from actions whose commitment depth matches the available knowledge. This relation becomes especially important when choices have irreversible effects.

10.2.7 Irreversibility

Irreversibility concerns the degree to which an action changes the future action field in ways that are costly, incomplete, or impossible to undo within the relevant horizon. Many actions are partly reversible: a policy can be amended, a device removed, a programme redesigned, or a contract renegotiated. Yet reversal can still leave residual effects through sunk costs, altered expectations, lost opportunities, institutional learning, ecological change, damaged relations, or path dependence. Application-dominant praxis therefore benefits from treating reversibility as graded and multi-dimensional.

The relevant question is not simply whether an intervention can technically be stopped. A system can be shut down while its data, incentives, dependencies, reputational effects, or distributional consequences persist. A legal rule can be repealed while cases decided under it remain consequential. An infrastructure can be abandoned while spatial patterns and financial commitments continue. A temporary organizational arrangement can change expectations that shape later cooperation. Reversibility should therefore be assessed in relation to the generative consequences of prior action.

Definition 10.31 (Practical irreversibility). *Practical irreversibility* is the degree to which an action commits a relational configuration to consequences, dependencies, losses, or foreclosed possibilities that cannot be restored within the relevant horizon at acceptable practical cost.

This definition makes irreversibility horizon-dependent. A consequence can be reversible over decades and effectively irreversible for people affected during the next year. It is also value-dependent because the acceptability of restoration cost requires judgment. The concept therefore joins temporal, material, institutional, and normative dimensions.

Irreversibility increases the practical significance of uncertainty. If an action can be cheaply revised after new evidence appears, residual uncertainty can often be managed through experimentation and monitoring. If the action closes future options or creates durable exposure, the same uncertainty warrants a different decision architecture. This relation does not generate a universal rule favoring inaction. Non-action can itself be irreversible when opportunities disappear, harms accumulate, or capacities degrade.

Proposition 10.32 (Reciprocal irreversibility assessment). *Practical assessment of irreversibility should compare the option-changing consequences of action, non-action, continuation, and delay within the relevant horizon, because preserving one option set can simultaneously foreclose another.*

Proposition 10.32 prevents reversibility from becoming a one-sided argument for postponement. Waiting can preserve information-gathering opportunities while allowing material deterioration. Immediate intervention can preserve a threatened system while creating institutional lock-in. A staged intervention can preserve both learning and partial protection. The practical problem concerns the configuration of option value across competing trajectories.

Irreversibility also creates responsibility across time. Decisions taken under current uncertainty can constrain future actors who neither participated in the decision nor share present values. This intertemporal distribution of agency becomes especially important for long-lived institutions, technologies, environments, and infrastructures. Later sections on responsibility and justice will develop the normative implications.

The interaction among necessity, incomplete knowledge, uncertainty, normative commitment, plural values, urgency, and irreversibility produces the principal contradiction described at the beginning of the section. The final subsection clarifies how this contradiction can change through praxis rather than remaining a static condition.

10.2.8 Transformation of the Principal Contradiction

The principal contradiction of application-dominant praxis is dynamic. Inquiry can reduce some uncertainties. Participation can reveal previously unrecognized values. Institutional reform can redistribute authority. Pilot interventions can generate evidence. Delay can increase urgency. Early action can create lock-in. New harms can become visible. A practical configuration can therefore transform the relative importance of the dimensions developed above.

Transformation can occur through epistemic change. Additional observation, experimentation, historical comparison, modeling, or situated knowledge can improve understanding of mechanisms and consequences. Yet epistemic improvement may also reveal greater complexity. A decision initially represented as technically simple can become normatively or institutionally more difficult once affected relations are recognized. Knowledge can therefore transform the contradiction without necessarily making the decision easier.

Transformation can occur through practical design. Reversible staging, modular intervention, option preservation, contingency resources, distributed monitoring, or adaptive governance can reduce the cost of being wrong. These designs change the relation between uncertainty and consequence. They are especially important because some uncertainty is resistant to ex ante elimination and can only be learned through

interaction with the practical field.

Transformation can also occur through normative and institutional processes. Deliberation can clarify values. Participation can alter problem formulation. Negotiation can generate acceptable compromises. Rights or side constraints can remove some options from consideration. Institutional authorization can clarify responsibility. Appeal and contestation can keep decisions reopenable. These processes alter the structure within which uncertainty and action are coordinated.

A further transformation occurs when action changes the field itself. Application generates new relations, evidence, dependencies, capacities, expectations, and constraints. The principal contradiction after intervention can therefore differ from the contradiction that motivated the intervention. A programme initially dominated by uncertainty about effectiveness can later become dominated by distributional conflict. A technical intervention can generate institutional dependence. An emergency response can evolve into a long-term governance arrangement. Praxis analysis should therefore remain stage-sensitive.

Definition 10.33 (Contradiction transformation). *Contradiction transformation* is a change in the composition, intensity, distribution, or practical organization of the tensions that structure application-dominant praxis as knowledge, values, institutions, relations, capacities, and consequences evolve.

This definition avoids treating successful praxis as the permanent elimination of contradiction. Some tensions can be reduced, others displaced, and new ones generated. A decision that resolves an immediate coordination problem can create a later accountability problem. An intervention that reduces one form of risk can concentrate another. A consensus can become unstable as circumstances change. The relevant criterion is therefore whether praxis can recognize and reorganize changing tensions with appropriate learning, responsibility, and revision.

Proposition 10.34 (Recursive transformation of application-dominant praxis). *Application-dominant praxis should be understood as recursively transforming its own principal contradiction because inquiry, judgment, action, and consequence continuously alter the conditions under which subsequent action becomes necessary and justifiable.*

Proposition 10.34 connects the present section to the action–learning recursion defined in Section 10.1. It also clarifies the relationship between Chapter 10 and Chapter 11. Chapter 10 develops the constitutive landscape of practical action. Chapter 11 will examine methodologies through which specific dimensions of that landscape can be diagnosed, modeled, deliberated, monitored, and revised.

At the present stage, however, the contradiction remains too abstract for direct practical analysis. Necessity, uncertainty, value plurality, urgency, and irreversibility always occur somewhere: within a historically formed configuration of actors, institutions, resources, capacities, constraints, and relations. The next analytical step is therefore to reconstruct the *practical situation* within which the principal contradiction acquires determinate form. Section 10.3 develops that relational and historical configuration.

10.3 Practical Situation

Section 10.2 identified the principal contradiction of application-dominant praxis as the organization of consequential action while knowledge, values, authority, timing, and reversibility remain partly open. The present section specifies the relational field within which that contradiction becomes practically determinate. Its objective is to develop the concept of a *practical situation* as a historically formed and revisable configuration of positions, institutions, material conditions, relations, constraints, capacities, and uncertainties. The discussion proceeds from the relational constitution of situations through historical, institutional, material, and relational positioning, then examines constraints, capacities, practical uncertainty, and situation revision. The method is reconstructive and relational: a practical situation is treated as an analytical specification of relevant conditions for action rather than as a self-evident inventory of facts.

The distinction between a practical situation and a practical problem is central to the chapter architecture. A situation is broader than any particular problem formulation. It contains relations, histories, capacities, burdens, opportunities, temporal processes, and possible developments that can become differently salient from different positions. Problem formation, developed in Section 10.4, selects and organizes some of these elements into an actionable interpretation. The present section therefore establishes the situational field before examining how that field becomes articulated as a practical problem.

Definition 10.35 (Practical situation). A *practical situation* is a stage-, scale-, and standpoint-indexed relational configuration within which consequential praxis is being organized, including the historically formed positions, institutions, material conditions, existing relations, constraints, capacities, temporal processes, and uncertainties that are relevant to possible action and its consequences.

Definition 10.35 emphasizes indexing because the practical meaning of a configuration depends partly on where and when it is reconstructed. A municipal authority, a resident, a technical operator, a future affected population, and an ecological subsystem can occupy different positions within one wider process. Their exposure, information, authority, dependencies, and available actions can diverge. An analysis that selects one standpoint as exhaustive can therefore omit relations that become decisive elsewhere in the same configuration.

The definition also treats relevance as revisable. Practical analysis cannot include an unlimited history or an indefinitely extended relational field. Boundaries are required for action and inquiry. Yet boundary selection can exclude affected entities, long-horizon consequences, hidden dependencies, or cross-scale processes. A practical situation is therefore neither the totality of reality nor a closed dataset. It is a disciplined reconstruction whose adequacy depends on whether its boundary, scale, temporal horizon, and standpoint are appropriate to the consequences under consideration.

Table 10.3: Constitutive dimensions of a practical situation in application-dominant praxis.

Dimension	Analytical focus	Practical significance
Historical position	Pathways, prior commitments, inherited categories, accumulated consequences, and temporal stage.	Shapes dependencies, expectations, available options, and the meaning of present action.
Institutional position	Mandates, rules, jurisdiction, authority, routines, and organizational relations.	Conditions who may decide, implement, contest, revise, or bear responsibility.
Material conditions	Bodies, infrastructures, technologies, environments, resources, and physical dependencies.	Establishes enabling conditions, exposure, durability, operational limits, and consequence pathways.
Existing relations	Dependence, cooperation, conflict, trust, recognition, information, exchange, and coordination.	Structures how actions propagate and how burdens or capacities are distributed.
Constraints	Conditions that restrict feasible, legitimate, sustainable, or timely action.	Narrows practical possibility in actor-, scale-, and time-specific ways.
Capacities	Relational abilities to perceive, decide, act, coordinate, sustain, learn, repair, and revise.	Determines which possibilities can be converted into effective and revisable praxis.
Practical uncertainty	Residual openness concerning conditions, mechanisms, values, responses, and consequences.	Qualifies confidence, sequencing, safeguards, monitoring, and revision requirements.

Table 10.3 summarizes the main dimensions developed below. The dimensions are analytically distinguishable while remaining mutually constitutive. Institutional authority can depend on material infrastructure. Material access can depend on social relations. Capacity can be constrained by law, time, trust, or technology. Historical commitments can harden into institutional routines and physical systems. Practical uncertainty can arise from limited knowledge of any of these relations and from the possibility that the relations themselves will change during action.

Proposition 10.36 (Relational constitution of practical relevance). *The practical relevance of a condition depends on its relation to possible action, affected positions, temporal horizons, and consequence pathways; relevance should therefore be reconstructed within the practical configuration rather than assigned from descriptive prominence alone.*

Proposition 10.36 matters because conspicuous features can dominate attention while quieter relations organize consequence. A visible technical failure may depend on institutional maintenance practices. An immediate shortage may reflect a longer sequence of access decisions. A conflict framed as interpersonal may be sustained by organizational incentives. A stable outcome can conceal accumulated vulnerability. Situational analysis therefore asks how conditions participate in the generation, transmission, amplification, mitigation, or transformation of practical consequence.

10.3.1 Situation as Relational Configuration

The first task is to clarify what it means to treat a situation relationally. The analytical unit is neither an isolated decision-maker nor a static environment surrounding that decision-maker. A practical situation is constituted through relations among actors, affected subjects, institutions, material systems, histories, representations, and possible futures. The significance of each element depends partly on the relations through which it enters the field of action.

A relational description changes the interpretation of familiar practical categories. A resource becomes practically meaningful through access, control, convertibility, timing, maintenance, and dependence. An institutional rule matters through the actors able to invoke, interpret, enforce, circumvent, or contest it. Information matters through credibility, accessibility, authority, and the capacity to act upon it. A technology matters through infrastructures, users, standards, complementary skills, dependencies, and failure modes. Even an apparently individual capacity can depend on education, recognition, networks, legal status, tools, health, time, and collective support.

The practical situation therefore includes both entities and relations, while granting analytical priority to the configuration through which entities acquire practical significance. This does not require the claim that entities can be reduced to relations. Ontological suspension remains appropriate. The methodological point is more limited: consequential praxis is rarely intelligible through an inventory of isolated attributes because action propagates through structures of dependence, coordination, exclusion, feedback, and transformation.

Definition 10.37 (Situational position). A *situational position* is the relationally constituted location of an actor, affected subject, institution, or other practically relevant entity within a specified configuration, including its access, exposure, authority, dependencies, capacities, obligations, and channels of influence.

Situational position is indexed to the practical configuration. The same organization can be powerful in one relation and dependent in another. A person can possess formal rights while lacking the material or informational capacity required to exercise them. A technical operator can have extensive knowledge of system behavior while holding little authority over strategic decisions. A community can carry high exposure to consequences while having limited representation in problem formation. Position therefore cannot be inferred from a single ranking of power or resources.

The relational character of situations also introduces perspective without reducing analysis to subjectivity. Different positions disclose different parts of a configuration because they encounter different consequences, records, routines, and dependencies. Situated knowledge can therefore contribute distinctive evidence. At the same time, each position remains partial. A practical reconstruction can combine multiple standpoints while preserving disagreement about interpretation, value, and consequence.

A situation can also contain latent relations that become visible only when conditions change. Backup infrastructure matters differently during ordinary operation and during failure. Informal care networks can remain analytically peripheral until formal provision becomes unavailable. A legal provision can remain dormant until invoked. Ecological dependence can become salient after threshold change. Application-dominant praxis therefore benefits from examining both currently activated relations and plausible relations that can become consequential under

disturbance or transition.

Proposition 10.38 (Situational activation). *Relations that appear practically secondary under one configuration can become organizing under altered material, institutional, temporal, or interpretive conditions; situational analysis should therefore distinguish current salience from potential activation.*

Proposition 10.38 supports a dynamic understanding of context. A practical situation is not a frozen background against which action occurs. Action changes relations, and changing relations alter the situation in which later action is judged. This dynamic feature becomes especially important once interventions create new dependencies, expectations, data, constituencies, or risks.

The relational configuration also has a boundary problem. Expanding the boundary can reveal additional consequences, yet unlimited expansion makes practical analysis unusable. Boundary discipline therefore requires explicit justification. Analysts should specify the stage, scale, standpoint, affected field, and time horizon that organize the current reconstruction, while leaving open the possibility that consequences crossing those boundaries will require revision. The practical situation is consequently a bounded representation of an open relational field.

10.3.2 Historical Position

A practical situation is historically positioned because present relations inherit prior decisions, events, classifications, investments, conflicts, settlements, and accumulated consequences. Historical position concerns the pathway through which the current configuration became possible and the degree to which that pathway conditions present action. Its role in situational analysis is to prevent current feasibility from being mistaken for an ahistorical property of the field.

History enters praxis through several mechanisms. Earlier commitments can create infrastructures that favor some actions over others. Institutional precedents can shape expectations and standards of legitimacy. Past harms can influence trust, participation, and the interpretation of new intervention. Previous successes can produce routines that remain useful under some conditions and brittle under others. Categories established for earlier purposes can continue organizing records, eligibility, or recognition after the surrounding reality has changed.

Historical position also includes temporal stage. A configuration can be emerging, consolidating, mature, destabilizing, recovering, or undergoing transformation. The practical significance of an intervention can differ across these stages even when its immediate form is similar. Early intervention can preserve flexibility. Later intervention can benefit from richer evidence while facing stronger dependencies. Recovery can require different capacities from expansion. A stage-sensitive analysis therefore asks how present action interacts with accumulated path formation.

Definition 10.39 (Historical practical position). *The historical practical position of a configuration is the temporally situated pattern of inherited commitments, accumulated consequences, institutional memories, path dependencies, unresolved claims, and emerging possibilities that conditions present praxis.*

Historical position should not be interpreted as historical determinism. Inherited structures constrain and enable without fully determining later trajectories. New relations, technologies, coalitions, interpretations, shocks, and institutional reforms can

transform available possibilities. The analytical purpose of history is therefore to identify how the present field has been generated and where prior trajectories continue to shape the costs, legitimacy, visibility, and feasibility of action.

The historical horizon selected for reconstruction should follow the practical problem rather than a fixed chronological rule. Some decisions require attention to recent operational history. Others depend on institutional formation over decades or on intergenerational consequences. The relevant depth can also differ across dimensions of the same situation. A technical component can have a short replacement cycle while the social trust surrounding its use reflects a much longer history.

Historical reconstruction additionally affects responsibility. Current actors can inherit obligations generated before their participation, and present action can create conditions borne by later actors. Responsibility therefore has temporal extension. The details of responsibility are developed in Section 10.13; within situational analysis, the key point is that the present cannot be treated as an isolated decision moment detached from inherited burdens and future consequence.

Proposition 10.40 (Historical conditioning of practical possibility). *Present action spaces are partly generated by prior commitments and accumulated consequences; assessment of current feasibility should therefore include the historical processes that produced enabling conditions, dependencies, expectations, and foreclosures where these materially affect praxis.*

This proposition also clarifies why apparent inertia can have multiple sources. Continuity can reflect deliberate preservation, material sunk structures, institutional mandate, social expectation, contractual dependence, loss aversion, limited alternatives, or a history of failed reform. Different historical sources imply different practical responses. Situational analysis therefore benefits from reconstructing the mechanisms of continuity rather than treating persistence as a single phenomenon.

10.3.3 Institutional Position

Institutional position specifies how rules, mandates, jurisdictions, organizational routines, offices, procedures, and recognized forms of authority enter the practical situation. Institutions coordinate action by stabilizing expectations and distributing roles, while also shaping which problems become legible, who may decide, what evidence counts, and how consequences are recorded. Application-dominant praxis therefore occurs within institutional arrangements even when its immediate form appears informal.

Institutional position has several dimensions. Formal mandate establishes what an organization or office is authorized or required to do. Jurisdiction identifies the domain within which that authority can operate. Procedure shapes how decisions are initiated, reviewed, challenged, and implemented. Budgetary and staffing structures condition operational capacity. Record systems influence what becomes visible over time. Accountability arrangements distribute responsibility for consequences. Informal norms can modify the practical operation of each formal component.

The same practical situation can cross multiple institutional locations. A decision can involve professional standards, local administration, national regulation, contractual relations, community governance, technical operators, and transnational standards simultaneously. Their boundaries can overlap imperfectly. One institution can possess authority without capacity, another capacity without jurisdiction, and

another relevant knowledge without formal standing. Coordination problems often emerge from these misalignments.

Definition 10.41 (Institutional practical position). An *institutional practical position* is the configuration of mandate, jurisdiction, authority, procedure, resources, accountability, and inter-institutional dependence through which an institution or institutional role participates in consequential praxis.

Institutional position is also historically variable. Mandates can be reinterpreted, emergency conditions can activate exceptional procedures, informal practices can become regularized, and new institutions can be created when existing arrangements fail to coordinate emerging problems. Institutional analysis therefore concerns practical operation in a particular stage rather than an abstract description of organizational charts.

A critical issue is the relation between formal authority and practical consequence. An actor with limited formal authority can nonetheless have substantial influence through technical control, information, agenda setting, financing, logistical access, or public legitimacy. Conversely, an institution with extensive legal authority can remain practically weak when implementation capacity, trust, information, or coordination is limited. Situational analysis should therefore reconstruct how institutional rules interact with actual relational capacity.

Institutional position also shapes epistemic access. Reporting systems, professional categories, audit requirements, eligibility rules, and administrative boundaries determine which manifestations enter formal knowledge systems. Some consequences become highly legible because institutions are designed to measure them. Others remain dispersed across departments, informal networks, or populations with weak representation. Practical situation reconstruction should therefore examine how institutional arrangements generate both visibility and obscurity.

Proposition 10.42 (Institutional mediation of praxis). *Institutional rules and organizational arrangements mediate both action and knowledge by distributing authority, resources, records, categories, and channels of contestation; situational analysis should therefore examine institutional form as part of the practical configuration rather than as an external administrative layer.*

The proposition prepares later analysis of power, participation, responsibility, and collective praxis. At the situational level, its immediate implication is diagnostic: a practical difficulty can arise from misalignment among mandates, capacities, information, and consequences. Such misalignment may require institutional transformation rather than a better choice by any single decision-maker.

10.3.4 Material Conditions

Material conditions anchor application-dominant praxis in bodies, infrastructures, technologies, environments, spatial arrangements, resources, and physical dependencies. Their role is to specify the enabling and limiting conditions through which practical intentions become effective action. A relational theory of praxis therefore retains materiality as a constitutive dimension rather than treating action as a sequence of preferences and decisions alone.

Material conditions influence what can be done, how quickly it can be done, who can access the means of action, how consequences propagate, and how durable an

intervention becomes. Transport systems shape mobility and emergency response. Communication infrastructure shapes coordination. Buildings and spatial design shape access and interaction. Technologies create capabilities while introducing maintenance and compatibility requirements. Ecological systems condition resource availability and exposure. Bodies introduce limits of endurance, vulnerability, perception, and care.

Materiality also has temporal depth. Infrastructure embodies previous investments and design assumptions. Durable systems can stabilize beneficial practices while producing path dependence. Maintenance deficits accumulate gradually and may become visible only during stress. Material stocks can buffer temporary disturbance. Supply chains can transmit distant disruptions into local practical situations. Situational analysis therefore examines material condition as a dynamic relation between present functioning, inherited structure, and future sustainment.

A material resource is not equivalent to usable capacity. Effective use can require rights of access, knowledge, complementary infrastructure, time, energy, institutional permission, trust, and maintenance. Two actors facing the same nominal stock can therefore occupy sharply different practical positions. The relational interpretation of materiality links this subsection directly to existing relations and capacities.

Definition 10.43 (Material practical condition). A *material practical condition* is a bodily, technological, infrastructural, environmental, spatial, or resource configuration whose properties and relations materially shape the feasibility, timing, durability, exposure, or consequences of possible action.

Material conditions can also carry normative and political significance because their design distributes access, convenience, risk, and dependence. An infrastructure can make some actions routine and others costly. A technical interface can privilege some users. Spatial arrangements can facilitate participation or exclusion. Environmental burdens can be concentrated across particular places or populations. These consequences do not derive from materiality alone, yet material configurations can stabilize them over long periods.

Practical analysis should also distinguish stocks from flows and operational states from latent capacities. A reserve can exist without being rapidly deployable. A service can function at ordinary load while lacking resilience to disturbance. A technology can be technically available while absent from the relevant place. A material system can have redundancy that becomes visible only during failure. Such distinctions become important when application-dominant praxis operates under urgency.

Proposition 10.44 (Material mediation of practical feasibility). *Practical feasibility depends on the relation between intended action and the material conditions required to initiate, sustain, coordinate, and revise it; nominal availability of resources or technology therefore provides only a partial account of actionable capacity.*

The proposition avoids a narrow interpretation of feasibility. A proposed action can be technically possible while practically fragile because maintenance, logistics, staffing, energy, access, or recovery capacity are insufficient. Conversely, local improvisation can create feasible pathways that formal planning overlooked. Material situational analysis should therefore remain attentive to both durable structures and emergent arrangements.

10.3.5 Existing Relations

Existing relations connect historical, institutional, and material conditions into an operative practical field. They include dependence, cooperation, conflict, trust, authority, exchange, care, information, recognition, coordination, obligation, representation, and other relational structures through which actors and systems affect one another. Their role in situational analysis is to explain how actions travel through the configuration and why similar interventions can produce different consequences across relational settings.

Relations can enable action by coordinating complementary capacities, sharing information, legitimizing authority, sustaining trust, or distributing workload. They can also transmit vulnerability, concentrate control, reproduce exclusion, amplify failure, or make exit costly. The same relation can contain enabling and constraining features simultaneously. Dependence, for example, can provide reliable access to specialized capacity while increasing exposure to disruption or control. Stability can support long-term cooperation while making institutional change difficult.

The density and topology of relations matter, yet formal network representations capture only part of their practical content. Two connections can differ in trust, authority, reciprocity, duration, visibility, enforceability, and emotional significance. A relational map therefore requires qualitative interpretation in addition to structural representation where such differences affect consequence. Methodological pluralism remains important even within apparently network-like situations.

Existing relations also structure information. People learn through professional networks, local experience, institutional reports, informal communication, sensors, documents, and public narratives. Information can travel unevenly. Some actors can observe consequences early while decision-makers receive delayed summaries. Some knowledge can remain tacit or difficult to translate into authorized evidential forms. Situational analysis should therefore ask how information relations affect practical judgment.

Definition 10.45 (Practical relation). A *practical relation* is a relation whose operation materially influences access, exposure, coordination, authority, information, obligation, capacity, or consequence within the practical situation under analysis.

The definition uses practical relevance rather than an exhaustive ontology of relation. Many relations can exist within a field while only some materially affect the current action problem. Their relevance can change over time. A relationship that initially appears peripheral can become decisive after a disturbance, institutional transition, or shift in objectives. Situational analysis should therefore preserve revisability in the relational map.

Relations can also connect scales. Household conditions can depend on municipal infrastructure. Local organizations can depend on national funding. Regional ecological systems can influence local production. Technical standards established internationally can structure local design choices. Cross-scale relations can create situations in which authority and consequence reside at different levels. Application-dominant praxis then requires coordination across partially overlapping action spaces.

Proposition 10.46 (Relational transmission of consequence). *The consequences of action frequently propagate through existing relations of dependence, coordination, information, authority, and material connection; assessment of a practical situation should therefore include plausible transmission pathways beyond the immediate target of in-*

tervention.

This proposition is especially important when an intervention appears local. Changing one relation can alter incentives, trust, workload, access, or risk elsewhere. A practical situation is thus partly defined by the pathways through which consequence can travel. Later sections on risk, power, participation, and justice develop these implications more fully.

10.3.6 Constraints

Constraints specify the conditions that restrict practical possibility. Their role is to explain why an action that appears desirable or technically imaginable may remain unavailable, illegitimate, unsustainable, or excessively costly within a particular configuration. Constraints are relational because their effect depends on actor, position, scale, timing, and available complementary capacities.

A constraint can be material, legal, institutional, financial, temporal, informational, organizational, cognitive, social, ecological, or normative. These categories can overlap. A legal restriction can become materially consequential through enforcement infrastructure. A financial limitation can reflect institutional eligibility rules. A time constraint can arise from ecological change or administrative deadlines. A social constraint can be stabilized through spatial design. Situational analysis therefore examines how constraints are generated and maintained rather than merely listing them.

Definition 10.47 (Practical constraint). A *practical constraint* is a condition or relational configuration that restricts the feasibility, legitimacy, timing, sustainability, or revisability of an action for a specified actor or collective within a specified practical horizon.

This definition makes constraints indexed rather than absolute. A requirement that constrains one actor can enable coordination for another. A safety standard can restrict rapid deployment while preserving trust and reducing downstream risk. Limited budgets constrain expenditure while creating incentives for prioritization. Physical limits can make some options unavailable across many actors, yet technological or institutional change can alter their practical significance. Constraint analysis should therefore distinguish hard limits from transformable conditions.

Constraints can also be generated by prior action. Commitments consume resources and create obligations. Successful programmes can generate demand that exceeds capacity. Institutional reforms can produce transition costs. Technologies can lock organizations into standards or vendors. Public promises can narrow later political discretion. Application-dominant praxis thus acts inside a constraint landscape that it partly inherits and partly produces.

Constraint interactions are often more important than isolated constraints. A modest informational limitation can become severe when combined with urgency and centralized authority. A material shortage can be manageable when coordination is strong and difficult when trust is low. A legal pathway can exist while procedural complexity makes it practically inaccessible. Situational analysis therefore benefits from identifying clusters of constraints and the relations among them.

Proposition 10.48 (Constraint dependence on configuration). *The practical force of a constraint depends on its interaction with capacities, institutions, time, relations, and alternative pathways; assessment should therefore distinguish the existence of a limit-*

ing condition from the configuration through which it becomes binding.

This distinction has direct practical importance. If a constraint is binding because a complementary capacity is absent, capacity building can change the situation. If it arises from a legitimate safeguard, bypassing it can transfer risk. If it reflects coordination failure, institutional redesign can be more effective than resource addition. If it is physical and durable, preserving options elsewhere can become more important. Constraint diagnosis therefore prepares the analysis of action space in Section 10.7.

10.3.7 Capacities

Capacities specify what actors and collectives are able to perceive, decide, initiate, coordinate, sustain, absorb, learn from, and revise within the practical situation. Their role is complementary to constraint analysis. Practical possibility emerges through the relation between enabling capacities and limiting conditions, with both changing through action and history.

Capacity should be understood relationally. Expertise becomes practical capacity when it can access relevant information, communicate with decision-makers, and influence action. Financial resources become capacity when they can be mobilized at the required time and converted into appropriate means. Legal authority becomes capacity when implementation structures exist. Social trust becomes capacity when it supports coordination under uncertainty. Technical infrastructure becomes capacity when people can operate, maintain, repair, and adapt it.

Definition 10.49 (Practical capacity). A *practical capacity* is a relationally supported ability to perform one or more practically relevant functions, including perception, interpretation, decision, coordination, implementation, sustainment, adaptation, repair, learning, or revision, within a specified situation and horizon.

Capacity is therefore function-specific. An organization can be strong in implementation and weak in learning. A community can possess rich situated knowledge and limited formal authority. A technical team can rapidly prototype while lacking the capacity to sustain long-term operation. An institution can coordinate routine activity effectively and respond poorly to novel disturbance. Situational analysis should identify the capacities required by the practical configuration rather than rely on aggregate labels such as strong or weak institutions.

Capacities can also be distributed across relations. Collective capacity may exceed the capabilities of any individual member when coordination allows specialization and complementarity. It can also fall below the sum of individual capabilities when mistrust, incompatible procedures, or fragmented authority prevent effective combination. The relation between individual and collective capacity is therefore organizational rather than additive.

A further distinction concerns action capacity and adaptive capacity. The ability to initiate an intervention can exceed the ability to monitor consequences, sustain support, correct error, compensate affected subjects, or withdraw safely. High initial action capacity paired with low revision capacity can create fragile praxis. Application-dominant analysis should therefore examine the full lifecycle of capacity required by consequential action.

Proposition 10.50 (Capacity for revision). *Where consequences remain uncertain or conditions are expected to change, the capacity to observe, learn, repair, and revise*

forms part of practical capacity rather than an optional activity added after implementation.

Proposition 10.50 links situational analysis to the principal contradiction developed in Section 10.2. Residual uncertainty cannot always be removed before action. In such cases, practical adequacy depends partly on the ability to detect divergence and respond to it. The capacity to revise therefore becomes a constitutive feature of responsible action under incomplete knowledge.

Capacity analysis also raises distributional questions. Some actors can possess the capacity to act while others possess the capacity to bear or resist consequences. Some can exit a failing arrangement while others remain dependent on it. Some can generate data while others lack access to the resulting knowledge. These asymmetries prepare later analysis of power, participation, and justice, but they already matter for reconstructing the practical situation accurately.

10.3.8 Practical Uncertainty

Practical uncertainty concerns the residual openness of the situation as reconstructed for action. Section 10.2 introduced uncertainty as a constitutive dimension of the principal contradiction. The present subsection locates uncertainty within the situation itself by asking what remains unknown, indeterminate, contested, or liable to change across historical, institutional, material, relational, and normative dimensions.

Practical uncertainty can arise from limited observation, measurement error, incomplete causal understanding, disagreement about interpretation, changing behavior, hidden dependencies, contested values, institutional response, strategic interaction, emergent phenomena, and unforeseen consequences. Some uncertainties can be reduced through additional inquiry. Others persist because the underlying configuration remains dynamic, because relevant events are rare, because actors adapt, or because values and institutions change during the period of action.

A useful situational analysis therefore avoids compressing uncertainty into a single confidence measure. Different uncertainties require different practical responses. Uncertainty about current conditions can motivate observation. Uncertainty about mechanism can motivate experimentation or comparison. Uncertainty about stakeholder response can motivate participation and staged implementation. Uncertainty about irreversible harm can motivate option preservation and safeguards. Normative uncertainty can motivate explicit deliberation and contestability.

Definition 10.51 (Situational practical uncertainty). *Situational practical uncertainty* is the residual openness relevant to consequential praxis concerning the state, relations, mechanisms, values, responses, temporal development, or consequences of the practical configuration.

The definition includes normative and institutional openness because practical uncertainty exceeds predictive uncertainty. A decision can be causally predictable while authority remains contested. An intervention can have stable average effects while distributional consequences remain poorly understood. A material process can be well characterized while public response changes its feasibility. Situational uncertainty therefore concerns the whole configuration within which consequences are generated and judged.

Uncertainty is position-sensitive. An administrator can be uncertain about local

conditions that residents know well. Residents can be uncertain about institutional constraints visible to administrators. Technical specialists can understand failure mechanisms while affected users understand burdens created by workarounds. Combining standpoints can reduce some uncertainty, though disagreement can also reveal genuine plurality that should remain visible rather than be averaged away.

Practical uncertainty also changes through action. Intervention can reveal mechanisms, alter incentives, generate new data, create dependencies, and shift expectations. Some uncertainty decreases while new uncertainty emerges. Monitoring therefore observes a moving configuration rather than a fixed system. This dynamic feature prepares the need for situation revision.

Proposition 10.52 (Uncertainty as situationally differentiated). *Practical uncertainty should be differentiated by its object, source, affected positions, temporal horizon, and reversibility implications because distinct uncertainties can support distinct forms of inquiry, precaution, participation, sequencing, and revision.*

The proposition resists both overconfidence and undifferentiated caution. Praxis organized around application needs enough specificity to decide which uncertainty matters for which consequence. A low-confidence estimate concerning a reversible pilot can have different practical significance from moderate uncertainty concerning irreversible harm. The practical situation provides the context within which such differences become intelligible.

10.3.9 Situation Revision

The final task is to make the practical situation explicitly revisable. Situational reconstruction is performed under partial access and within a changing field. New evidence can reveal omitted relations. Action can alter material conditions. Participation can disclose affected positions that were previously absent. Institutional changes can redistribute authority. Disturbance can activate latent dependencies. Values and priorities can also change. A practical theory therefore requires procedures for re-opening the situation description itself.

Definition 10.53 (Situation revision). *Situation revision* is the reconstruction of the practical situation in response to materially relevant changes in evidence, relations, positions, institutions, material conditions, constraints, capacities, values, temporal stage, or observed consequences.

Revision can vary in depth. A local update can modify one parameter or factual assumption while preserving the wider situational frame. A structural revision can change the identified relations, relevant actors, scale, or institutional interpretation. A foundational revision can alter the boundary of the situation or the categories through which it is understood. Application-dominant praxis should distinguish these depths because they imply different demands on decision, governance, and evidence.

Revisions should also preserve lineage. When a situation specification changes, the prior account remains important for understanding why earlier decisions appeared justified and how the field evolved. Traceability allows later analysis to distinguish changes in evidence from changes in values, institutions, constraints, or objectives. It also supports accountability when consequences emerge from assumptions that were reasonable at one stage and became untenable later.

Definition 10.54 (Situation revision record). A *situation revision record* is a traceable account of materially significant changes in the boundaries, positions, evidence, relations, constraints, capacities, uncertainties, and temporal interpretation through which a practical situation is reconstructed across stages of praxis.

The required degree of formalization should scale with consequence. High-consequence institutional action can require extensive records, versioned assumptions, documented participation, and explicit revision triggers. Local and reversible action can use lighter forms. The underlying principle is continuity of practical intelligibility: later actors should be able to understand what changed in the situation and why the practical orientation changed with it.

Situation revision can be triggered by evidence, consequence, contestation, or change. Evidence can invalidate a factual assumption. Consequence can reveal an unanticipated transmission pathway. Contestation can disclose an affected position excluded from the original boundary. Institutional change can redistribute authority. Material deterioration can make a previously feasible option unavailable. A threshold event can activate relations that were formerly latent. Revision is therefore broader than updating a forecast.

Proposition 10.55 (Revisability of situation specification). A *practical situation should be treated as a revisable specification whose boundary, scale, standpoint, and constitutive relations are reopened when new evidence or changing consequences materially alter the conditions under which action is interpreted and justified*.

Revisability also places a limit on situational completeness. Application-dominant praxis rarely has the time or epistemic access required to produce a final description of the field. The aim is sufficient practical articulation for responsible action, accompanied by mechanisms that can detect when the articulation has become inadequate. This standard links situational analysis to later sections on decision thresholds, robustness, monitoring, and practical closure.

The relation between situation and problem can now be stated more precisely. A practical situation provides a structured account of the field in which consequential praxis unfolds. A practical problem emerges when some configuration of conditions becomes salient enough to require interpretation, boundary setting, and practical response. Different actors can identify different problems within the same wider situation, and different problem formulations can reorganize which features of the situation become central. Problem formulation can in turn reveal omissions in the prior situation specification.

Proposition 10.56 (Situation–problem recursion). *Practical situation reconstruction and practical problem formation are recursively related: a situation conditions which problems can become salient, while problem formation can reveal relations, positions, histories, or consequences that require revision of the situation specification*.

Proposition 10.56 establishes the transition to Section 10.4. The chapter has moved from the general constitution of application-dominant praxis, through its principal contradiction, to the relational field within which consequential action becomes situated. The next task is to examine how a practical problem is encountered, recognized, constructed, contested, historically formed, relationally constituted, and revised within that field.

10.4 Practical Problem Formation

Section 10.3 developed the practical situation as a historically formed and revisable relational configuration within which consequential praxis is organized. The present section examines the next analytical movement: the formation of a *practical problem* within that wider situation. Its objective is to distinguish encounter, salience, recognition, construction, contestation, historical formation, relational formation, and revision as related moments through which a condition becomes organized for practical judgment and response. The discussion is conceptual and diagnostic. It treats problem formation as a selective and consequential operation performed under partial access, while preserving the possibility that material conditions, harms, constraints, or dependencies possess practical significance before they are adequately recognized or represented.

Definition 10.57 (Practical problem). A *practical problem* is a provisionally bounded configuration of conditions, relations, consequences, and unresolved practical demands that has become sufficiently salient to require organized judgment concerning response, continuation, delay, revision, or other consequential orientation.

Definition 10.57 places the practical problem between the wider situation and later decision. The problem is narrower than the practical situation because it selects a configuration for focused response. It is broader than a single decision variable because its formation can involve contested boundaries, uncertain mechanisms, affected subjects, histories, institutional positions, and multiple possible orientations. A problem formulation therefore organizes attention before it organizes choice.

Table 10.4: Analytical moments in practical problem formation.

Moment	Analytical operation	Practical significance
Encounter	A condition, consequence, interruption, claim, or emerging possibility enters practical experience.	Creates an initial relation between the wider situation and possible response.
Salience	Some features acquire practical prominence from particular positions and horizons.	Directs scarce attention while leaving other features less visible.
Recognition	A condition is identified as requiring interpretation, responsibility, coordination, or response.	Converts experienced significance into an articulated practical concern.
Construction	Boundaries, categories, causal relations, affected positions, scales, and temporal horizons are provisionally specified.	Produces an actionable representation of what the problem consists in.
Competition	Alternative formulations organize the same situation through different boundaries, values, mechanisms, or priorities.	Reveals disagreement concerning what requires action and which consequences count.
Historical and relational reconstruction	The formulation is situated within inherited trajectories and operative relations.	Connects present difficulty to processes that generated, stabilized, or transformed it.
Revision	The formulation is reopened as evidence, consequences, participation, or conditions change.	Preserves learning and practical responsiveness across stages of action.

Table 10.4 presents these moments as analytically distinguishable rather than mechanically sequential. An encounter can immediately be interpreted through an inherited problem category. Recognition can precede adequate situational reconstruction. Competing formulations can alter what appears salient. Historical analysis can transform the boundaries of the problem. Intervention can generate evidence that reconstitutes the problem itself. Practical problem formation is therefore recursive and temporally layered.

A further distinction is necessary at the outset. The formation of a problem does not imply that the underlying condition is created by description. Material deterioration, exclusion, institutional failure, ecological change, bodily vulnerability, or dependence can exert consequences independently of whether authorized actors have recognized them. At the same time, practical access to such conditions is mediated through observation, language, categories, institutions, measurements, testimony, models, and standpoint. The practical problem is therefore neither a pure discovery of a fully pre-specified object nor a free construction unconstrained by reality. It is a revisable practical articulation formed through relations between consequential conditions and situated interpretation.

Proposition 10.58 (Practical mediation of problem formation). *Practical problem formation mediates between consequential conditions and organized response: the condi-*

tions constrain viable formulations, while standpoint, categories, institutions, values, and available evidence shape which aspects become visible, bounded, and actionable.

Proposition 10.58 provides the organizing principle for the section. It allows the analysis to take practical conditions seriously while also examining the epistemic and institutional work through which those conditions become objects of action.

10.4.1 Encounter with a Practical Problem

Problem formation often begins through an encounter. The encounter can take the form of an interruption, anomaly, complaint, observed harm, recurring failure, opportunity, unmet need, conflict, breakdown, threshold crossing, unexpected consequence, or discrepancy between expected and experienced conditions. Its analytical role is to mark the point at which some aspect of the practical situation acquires sufficient experiential or institutional presence to disturb an existing practical orientation.

An encounter need not begin with explicit diagnosis. A system can repeatedly require workarounds before its maintenance structure becomes an articulated problem. A community can experience increasing burdens before those burdens enter formal reporting channels. An organization can observe declining coordination while different units attribute the decline to different causes. A technical intervention can appear successful at one scale while generating unanticipated difficulties elsewhere. Encounter therefore precedes, and can remain less articulated than, a stabilized problem formulation.

The same situation can be encountered differently from different positions. An affected subject can encounter a condition as immediate burden. A practitioner can encounter it as operational difficulty. A regulator can encounter it as non-compliance. A researcher can encounter it as unexplained variation. A manager can encounter it as coordination failure. These encounters can refer to overlapping parts of one relational configuration while differing in temporality, language, available evidence, and practical stakes.

Definition 10.59 (Practical encounter). A *practical encounter* is an event or sequence through which some feature of a practical situation becomes experientially, materially, institutionally, or evidentially present enough to disturb, redirect, or call for examination of an existing practical orientation.

The definition includes opportunities as well as difficulties. Application-dominant praxis can be organized around the possibility of improving a condition, preserving a threatened capacity, using a temporary opening, or creating a new relation. A practical problem therefore need not be framed solely around damage. It can concern a mismatch between current and possible conditions, provided that the mismatch generates a demand for consequential judgment.

Encounter is also temporally structured. Some problems arrive abruptly through failure, disaster, conflict, discovery, or institutional change. Others emerge through accumulation. Small deviations can compound until a threshold is crossed. Burdens can be normalized for long periods before becoming visible to actors with decision authority. A slow process can become practically urgent when remaining options narrow. The date at which a problem is formally recognized can therefore differ substantially from the history through which it became consequential.

The distinction between encounter and formation helps explain why early response is often difficult. At the moment of encounter, evidence can be sparse, categories unstable, causal structure unclear, and relevant actors incompletely identified. Yet practical consequences can already be accumulating. Application-dominant praxis must therefore preserve the possibility of provisional attention without prematurely fixing the meaning of the encounter.

Proposition 10.60 (Encounter without completed formulation). *A practical encounter can justify intensified observation, communication, safeguarding, or provisional response before the problem has acquired a stable formulation, provided that the provisional status of the formulation remains explicit and revisable.*

Proposition 10.60 links encounter to the principal contradiction developed in Section 10.2. Consequential conditions can require action while interpretation remains incomplete. The challenge is to respond proportionately without allowing provisional categories to harden into unquestioned descriptions of the field.

10.4.2 Salience in Practice

Encounter alone does not determine which conditions receive sustained practical attention. Application-dominant praxis takes place under finite time, attention, institutional capacity, information, and authority. Some features of the situation therefore become more salient than others. Salience is the process through which a condition acquires practical prominence relative to competing demands.

Salience can arise through severity, frequency, novelty, visibility, proximity, symbolic significance, political attention, legal obligation, measured deviation, concentrated harm, institutional mandate, available indicators, media representation, professional routines, or the presence of actors capable of making a claim. These pathways differ in their relation to consequence. A highly visible condition can be less consequential than a diffuse process that lacks a clear indicator. A recurring burden can become normalized and thereby receive less attention than a rare disruption. A measurable variable can dominate a less measurable but practically important relation.

Definition 10.61 (Practical salience). *Practical salience* is the degree and form of practical prominence acquired by a feature of the situation within a specified standpoint, institutional setting, temporal horizon, and field of competing demands.

This definition treats salience as indexed rather than intrinsic. Conditions possess properties and consequences that can support attention, yet the route through which those properties become practically prominent depends on relations. A safety failure can be highly salient to exposed users and weakly represented in managerial reporting. A long-horizon risk can be salient to planners and comparatively remote to actors operating under immediate scarcity. A local loss can be decisive for a small population while remaining statistically minor within an aggregate indicator.

Salience therefore has a distribution. Different positions can possess different capacities to observe, report, classify, and amplify practical concerns. Institutional procedures can make some claims easy to register and others difficult to translate into recognized categories. Technical systems can continuously monitor some variables while leaving other consequences dependent on testimony. Professional training can orient attention toward familiar mechanisms. Existing concepts can render one pattern immediately legible while another remains difficult to name.

Proposition 10.62 (Distributed salience). *Practical salience is distributed across positions because actors differ in exposure, observation, interpretive resources, authority, communication channels, and capacity to convert experienced conditions into institutionally consequential attention.*

The proposition has two implications. First, low institutional salience provides limited evidence of low practical significance. A condition can remain weakly represented because the actors most affected possess limited access to recognized channels. Second, disagreement about salience can contain information. Different assessments can reflect distinct exposures, temporal horizons, responsibilities, or understandings of consequence. Such disagreement should therefore be examined before it is interpreted simply as noise or resistance.

Salience can also be generated by action. Once an intervention begins, monitoring systems can make certain effects more visible. Public consultation can bring previously marginal consequences into view. A pilot can reveal operational burdens. Litigation, audit, reporting, or evaluation can reclassify what counts as a significant condition. Practical salience can therefore be reshaped by the organization of praxis because intervention and observation can alter the field of attention. The underlying conditions remain capable of constraining these changes in attention.

A responsible problem-formation process should consequently distinguish salience from significance. Salience concerns practical prominence; significance concerns the interpreted importance of a condition for values, consequences, capacities, responsibilities, or future trajectories. The two can converge, but they can also diverge. Section 269 develops judgment of significance more fully. At the present stage, the important point is that attention allocation forms part of problem formation and should remain open to correction.

10.4.3 Problem Recognition

Problem recognition occurs when practical salience is articulated as a condition requiring organized interpretation or response. Recognition gives the encounter a more determinate practical status. Actors begin to ask which conditions require explanation, which consequences matter, whose responsibilities are implicated, what evidence is needed, and whether existing routines remain adequate.

Recognition can be informal or institutionalized. A practitioner can recognize a recurring pattern before an organization has a category for it. A community can recognize a burden before administrative data register it. An institution can formally recognize a problem through a declaration, review, complaint process, audit, threshold rule, emergency procedure, or planning cycle. These forms differ in authority and consequence. Formal recognition can mobilize resources, establish jurisdiction, trigger reporting duties, or authorize intervention. Informal recognition can provide earlier and more situated knowledge while lacking comparable institutional leverage.

Definition 10.63 (Problem recognition). *Problem recognition* is the practical articulation through which a condition or relational configuration is identified as requiring sustained interpretation, responsibility, coordination, or consequential response within a specified field of praxis.

Recognition is selective because a situation contains more relations than any practical process can address simultaneously. The act of recognition foregrounds some conditions and backgrounds others. It can identify a target population, responsible in-

stitution, temporal horizon, mechanism, or form of harm. These selections can be initially useful while remaining incomplete. Their practical importance requires them to be visible as selections rather than treated as transparent reflections of the whole situation.

Recognition can also be delayed. Institutional categories can lag behind emergent conditions. Existing routines can absorb anomalies without reclassifying them as problems. Benefits concentrated among influential actors can coexist with distributed burdens that remain weakly represented. A condition can fall between jurisdictions. Scientific uncertainty can be interpreted as grounds for postponing recognition even when exposure continues. Conversely, a rapidly recognized problem can be framed through categories imported from another context before local relations are adequately reconstructed.

Proposition 10.64 (Recognition threshold). *The threshold for recognizing a practical problem should be interpreted in relation to potential consequence, reversibility, affected positions, available response capacity, and the cost of delayed recognition, rather than through evidential confidence alone.*

Proposition 10.64 does not supply a universal threshold. Its role is to prevent a single epistemic criterion from carrying the whole practical burden. A weak signal concerning a highly reversible inconvenience can justify observation. A weak signal concerning severe and irreversible harm can justify earlier protective attention. A recurring burden documented through multiple situated accounts can warrant recognition even when a standardized indicator remains unavailable. The appropriate threshold depends on the configuration developed in Sections 10.2 and 10.3.

Recognition also has a reflexive dimension. Once a condition is named as a problem, actors can change behavior in response to the label. Resources can be redirected. Expectations can shift. Measurement can intensify. Institutions can defend or revise their role. Affected subjects can gain or lose visibility. The recognized problem thereby enters the causal and relational field it describes. Application-dominant praxis should account for this reflexivity when recognition itself changes incentives, identities, or relations.

10.4.4 Problem Construction

Recognition establishes that a practical concern requires organized attention. Problem construction specifies what that concern consists in. This movement introduces boundaries, categories, scales, temporal horizons, causal hypotheses, affected positions, relevant values, and provisional criteria of adequacy. The term *construction* refers to the analytical and practical work of forming an actionable representation; it does not imply that the underlying conditions lack material or relational reality.

Definition 10.65 (Problem construction). *Problem construction* is the process through which a recognized practical concern is provisionally organized into a bounded representation of relevant conditions, relations, histories, affected positions, consequences, uncertainties, and practical demands.

Construction is necessary because action requires some specification of relevance. An institution cannot investigate every relation simultaneously. A collective cannot deliberate across unlimited temporal horizons. A monitoring system cannot measure every possible consequence. Problem construction therefore reduces complexity. The central issue is whether the reduction preserves the relations necessary for

responsible judgment and whether omitted dimensions can be reopened when they become consequential.

Several operations are especially important. Boundary construction specifies which actors, places, institutions, systems, and time periods enter the problem. Category construction specifies how conditions are named and differentiated. Causal construction specifies which relations are treated as mechanisms, contributors, mediators, or contextual conditions. Temporal construction distinguishes immediate triggers from longer histories and future consequences. Normative construction identifies which states, burdens, capacities, rights, values, or opportunities make the condition practically significant. Responsibility construction identifies actors or institutions whose capacities and roles bear on response.

These operations are interdependent. A narrow temporal boundary can make an institutional failure appear as an isolated technical event. A narrow spatial boundary can hide displaced consequences. A category centered on individual behavior can obscure infrastructural constraints. A category centered on system performance can obscure unequal burdens. A problem defined through aggregate outcomes can underrepresent minority experiences. A formulation centered on immediate repair can neglect the conditions generating recurrence.

Proposition 10.66 (Problem formulation and practical possibility). *A problem formulation conditions practical possibility by shaping which causes, affected positions, responsibilities, evaluative criteria, and response pathways become visible within the field of action.*

The proposition does not mean that a formulation determines action uniquely. It means that formulations create structured fields of attention. If a recurring failure is constructed primarily as a training deficit, training interventions become salient. If the same failure is constructed as a coordination problem, organizational redesign becomes visible. If it is reconstructed as an infrastructure problem, investment and maintenance enter the action space. Each formulation can capture part of the situation while excluding other relations.

Problem construction should therefore preserve an explicit distinction between the *problem condition* and the *problem representation*. The first refers to the consequential configuration being addressed. The second refers to the situated account through which that configuration is made practically intelligible. The distinction parallels the broader epistemic separation between reality and representation developed earlier in the book. It allows practitioners to revise a representation without implying that the condition itself disappeared, and it allows changes in the condition to be distinguished from changes in interpretation.

Definition 10.67 (Practical problem formulation). *A practical problem formulation is a traceable representation that specifies the provisional boundary, relevant conditions and relations, affected positions, temporal horizon, principal uncertainties, and practical demands through which a recognized problem is organized for judgment and response.*

A useful formulation can remain plural and layered. One layer can specify immediate operational failure, another can reconstruct institutional causes, and another can identify long-horizon generative consequences. Such layering is often preferable to forcing a complex situation into one explanatory register. Methodological pluralism applies to problem construction because historical, interpretive, empirical, formal, and participatory approaches can reveal different aspects of the same practical con-

figuration.

10.4.5 Competing Problem Formulations

Practical situations frequently support more than one defensible problem formulation. Competing formulations can differ in boundary, scale, causal account, affected population, temporal horizon, normative emphasis, institutional jurisdiction, or preferred evidence. Their coexistence is a central feature of application-dominant praxis because the way a problem is formulated influences which actions appear relevant and who acquires authority within the response.

Competition among formulations can arise from partial knowledge. Different actors observe different portions of the field. It can arise from disciplinary perspective, because technical, legal, organizational, ecological, clinical, educational, or community-based approaches use different categories. It can arise from values, because actors disagree about which consequences deserve priority. It can arise from position and interest, because a formulation can distribute responsibility or resources differently. It can also arise from temporal horizon: an intervention that solves an immediate operational problem can intensify a longer-term dependency.

Definition 10.68 (Competing problem formulations). *Competing problem formulations* are distinct, practically consequential representations of an overlapping situation that differ in one or more dimensions of boundary, mechanism, scale, temporality, affected position, evaluative priority, responsibility, or response orientation.

Competition should not automatically be resolved by selecting the formulation with the greatest institutional authority or technical precision. Authority can be relevant to mandate, while situated experience can reveal omitted consequences. Technical precision can improve causal analysis, while a narrow model can exclude values that matter for legitimacy. Historical reconstruction can disclose path dependence that an immediate diagnostic frame misses. Participation can reveal burdens that aggregate data understate. The task is to examine what each formulation renders visible, what its backgrounds, and what practical consequences follow from adopting it.

A useful comparison can ask at least six questions. What boundary does the formulation draw? Which relations does it treat as causally or practically important? Which affected positions become visible? What temporal horizon does it privilege? Which values or criteria organize significance? What kinds of response become available or foreclosed? These questions turn disagreement about formulations into an object of inquiry.

Proposition 10.69 (Diagnostic value of formulation conflict). *Conflict among problem formulations can provide diagnostic information by revealing divergent standpoints, hidden assumptions, omitted relations, incompatible values, or differences in scale and temporal horizon that a single formulation leaves obscure.*

The proposition encourages structured comparison without implying that all formulations are equally adequate. Some can be contradicted by evidence, omit central affected positions, rely on untenable causal assumptions, or place the problem at a scale where response cannot address its generative conditions. Others can be useful for one operational purpose while inadequate for another. Evaluation therefore concerns fitness for the practical situation and the consequences of using the formulation, not merely internal coherence.

Formulation conflict can also expose power. Actors with authority over agenda setting, measurement, funding, classification, or public communication can stabilize one problem representation and marginalize alternatives. Section 275 develops power in praxis more directly. At the present stage, the relevant implication is that the practical dominance of a formulation should be distinguished from its epistemic or normative adequacy.

Where feasible, application-dominant praxis can preserve a portfolio of formulations during early stages rather than forcing immediate convergence. Parallel formulations can guide different inquiries, reveal different risks, or support staged action. Convergence can then occur where evidence, coordination, or practical necessity warrants it. In other cases, persistent plurality can remain part of the decision environment and should be carried forward explicitly into judgment.

10.4.6 Historical Formation of Practical Problems

A practical problem has a history even when the immediate encounter appears sudden. Historical formation concerns the trajectories through which the relevant conditions, categories, institutions, expectations, dependencies, and response capacities came to occupy their present configuration. Its role is to prevent present difficulty from being interpreted solely through the moment at which it became visible.

The history of a problem can include accumulated maintenance decisions, prior interventions, legal changes, organizational routines, technological adoption, demographic shifts, environmental transformation, educational pathways, financial commitments, patterns of trust, previous conflicts, or earlier attempts at reform. These processes can generate current constraints and capacities. They can also shape which explanations appear plausible and which responses remain institutionally imaginable.

Definition 10.70 (Historical formation of a practical problem). The *historical formation of a practical problem* is the sequence and interaction of prior events, relations, decisions, classifications, institutions, material transformations, and accumulated consequences through which the present problem condition and its available formulations became possible.

Historical formation operates at several levels. The condition itself can have a history, such as gradual infrastructure deterioration. The category used to name the condition can have a different history, such as changing professional or legal classifications. The institution responsible for response can have another history involving jurisdiction, mandate, and resource allocation. The population affected by the problem can have a history of differential exposure or exclusion. The response repertoire can be historically shaped by earlier successes, failures, and investments.

These histories can produce path dependence without making present action fully determined. Past choices can make some options inexpensive and others difficult. Existing infrastructures can stabilize particular practices. Institutional learning can expand capacity. Prior harms can reduce trust and thereby change the feasibility of participation. Earlier reforms can create legal or technical interfaces that enable later transformation. Historical analysis therefore identifies inherited structures while preserving the possibility of new trajectories.

Proposition 10.71 (Historical depth of problem adequacy). *Where inherited relations materially shape present constraints, capacities, exposure, or feasible response, an ade-*

quate practical problem formulation should include sufficient historical depth to explain those inherited conditions and their relevance to current action.

The required depth varies by problem. An acute equipment failure can require a short operational history. A persistent institutional disparity can require a much longer reconstruction. A sudden policy change can be understood only through the institutional rules that made the change consequential. Historical analysis should therefore be proportionate and problem-oriented while remaining alert to the possibility that a short time horizon itself produces misdiagnosis.

History also shapes practical memory. Institutions retain records unevenly. Some failures become encoded in standards and procedures; others disappear with staff turnover. Communities can retain experiential memory absent from formal archives. Data series can begin after an important structural change and thereby normalize the post-change condition as baseline. Historical problem formation should therefore examine the provenance and absences of practical memory as part of the evidence architecture.

Finally, historical formation can transform normative interpretation. A burden produced by a recent accident can raise different questions from an equivalent burden generated through a long sequence of exclusionary arrangements. Present consequence matters in both cases, while historical pathway can change responsibility, legitimacy, trust, reparative obligations, and the design of acceptable response. Later sections on responsibility and justice develop these implications more fully.

10.4.7 Relational Formation of Practical Problems

Historical depth explains how a problem emerged through time. Relational formation explains how it is constituted through dependencies, interactions, positions, institutions, material systems, information pathways, and cross-scale connections in the present field. Its central claim is that practical difficulty often resides in a configuration of relations rather than within an isolated object or actor.

A relationally formed problem can arise from mismatch. Authority can be separated from knowledge. Responsibility can be assigned without sufficient capacity. Resources can exist without access. Technical capability can exceed maintenance capacity. Benefits can accrue at one scale while burdens appear at another. Information can reach decision-makers after consequences have already propagated. Formal participation can exist while practical voice remains unequal. Each difficulty emerges through relations among otherwise familiar elements.

Definition 10.72 (Relational formation of a practical problem). The *relational formation of a practical problem* is the constitution of practical difficulty through patterns of dependence, interaction, separation, coordination, authority, access, information, material connection, recognition, and consequence among positions within the practical situation.

Relational analysis changes the location of intervention. If a problem is attributed to an individual actor, response can focus on knowledge, incentives, or behavior. If the same recurring outcome is generated by coordination failure among units, improving one actor may have limited effect. If the outcome is sustained by an institutional rule, local adaptation can shift burdens without changing the generative condition. If the problem emerges from cross-scale dependence, an intervention confined to one scale can remain fragile.

The practical unit of analysis should therefore follow consequence pathways. Section 10.3 introduced relational transmission of consequence. Problem formation uses that principle to ask where the condition is generated, where it becomes visible, where it is measured, where authority resides, where costs are borne, and where revision can occur. These locations can differ. A single label for the problem can conceal this distributed structure.

Proposition 10.73 (Relational displacement of problem location). *The location at which a practical problem becomes visible can differ from the relations through which it is generated, sustained, amplified, or transmitted; practical formulation should therefore distinguish sites of manifestation from sites of generative influence.*

This proposition has methodological consequences. Observation at the site of manifestation can document severity while providing limited evidence about mechanism. Historical inquiry can identify prior institutional transformations. Network or systems analysis can identify dependencies. Qualitative inquiry can reveal informal relations. Participatory methods can identify burdens and capacities inaccessible to central records. Formal modeling can test implications of hypothesized relational structure. No single method receives automatic priority; the practical problem determines which combination is warranted.

Relational formation also includes the relation between the problem and the act of responding to it. An intervention can redistribute workload, information, trust, authority, and dependence. Solving one manifestation can move the difficulty elsewhere. A temporary workaround can become institutionalized. A new monitoring system can improve visibility while altering behavior. A subsidy, prohibition, technical standard, educational programme, or organizational reform can create new relations whose consequences exceed the initial target. Problem formation should therefore include plausible response-induced transformations when they materially affect the field.

The relational perspective also prevents an excessively narrow opposition between internal and external causes. What appears external to one organization can be internal to a wider system. What appears individual at one scale can be relational at another. What appears structural at a large scale can still be mediated through concrete interactions. Scale selection should follow the problem's generative relations and practical responsibilities rather than disciplinary convention alone.

10.4.8 Revisability of Problem Formulation

The final requirement is revisability. Problem formulations are produced under incomplete knowledge within situations that can change during inquiry and action. New evidence can alter causal interpretation. Participation can reveal affected positions omitted from the original frame. Intervention can generate unanticipated consequences. Institutional change can redistribute authority. A previously peripheral relation can become decisive. Values can be reconsidered. The problem formulation should therefore remain capable of structured revision.

Definition 10.74 (Problem-formulation revision). *Problem-formulation revision* is the traceable modification of a practical problem's boundary, categories, causal interpretation, affected positions, temporal horizon, evaluative emphasis, uncertainties, or response-relevant relations in light of materially relevant evidence, consequence, contestation, or change.

Revision can occur at different depths. A parameter revision updates a factual estimate while preserving the frame. A relational revision changes the identified dependencies or affected positions. A boundary revision alters the scale, population, institution, or temporal horizon included in the problem. A categorical revision changes how the condition is classified. A generative revision changes the account of how the problem is produced or sustained. A normative revision changes which consequences or values organize practical significance.

These depths should be distinguished because they place different demands on continuity. A parameter update can leave the current response architecture intact. A boundary revision can require new participants, authority, data, or resources. A generative revision can redirect intervention toward different relations. A normative revision can reopen previously settled ends. Traceability allows actors to understand whether practical change arose from new facts, new interpretations, changed values, changed conditions, or changed responsibilities.

Definition 10.75 (Problem-formulation revision record). *A problem-formulation revision record is a proportionate account of materially significant changes in the problem's boundary, evidence, categories, affected positions, causal interpretation, historical depth, values, uncertainties, and response implications across stages of praxis.*

A revision record need not become administratively heavy in every setting. Its form should scale with consequence, institutional complexity, reversibility, and the number of affected positions. High-consequence collective action can warrant versioned formulations, explicit assumptions, documented disagreement, and predefined reopening triggers. Local and reversible action can use concise records. The common purpose is to preserve practical intelligibility across time.

Revisability also requires criteria for reopening. Useful triggers include evidence that contradicts a central assumption, emergence of severe unanticipated consequences, discovery of omitted affected subjects, failure of an intervention to influence the hypothesized mechanism, substantial change in material or institutional conditions, persistent contestation concerning boundaries or values, and a shift in reversibility or urgency. These triggers connect problem formation to later monitoring and practical closure.

Proposition 10.76 (Revisable problem adequacy). *A practical problem formulation is adequate provisionally when it supports responsible judgment at the relevant stage while retaining sufficient traceability and openness to incorporate materially important evidence, positions, relations, and consequences that emerge through subsequent praxis.*

The proposition defines adequacy through practical sufficiency and revisability rather than exhaustive description. Application-dominant praxis cannot generally wait for a final account of the situation. It can, however, require that the working formulation make its boundary, assumptions, uncertainties, and affected positions sufficiently explicit for responsible action and later correction.

Problem revision also recouples application with research. A contradiction between expected and observed consequences can create a new research question. Persistent disagreement among formulations can motivate comparative inquiry. A newly visible affected position can require qualitative or participatory investigation. Failure of an intervention can challenge a causal model. Application thereby generates epistemic demands that can shift a project temporarily toward research-dominant praxis before a revised practical orientation emerges.

Proposition 10.77 (Problem–judgment interface). *Practical problem formation establishes the provisional object of application-dominant judgment by specifying what is at stake, for whom, through which relations, across which horizon, and under which uncertainties, while leaving the evaluation of significance, urgency, acceptability, and practical orientation to subsequent judgment.*

Proposition 10.77 establishes the transition to Section 269. The chapter has moved from the constitution of application-dominant praxis, through its principal contradiction and practical situation, to the formation of a problem within that situation. The next task is to examine the forms of judgment through which practical significance, epistemic warrant, normative acceptability, urgency, and action orientation are assessed under conditions of incomplete knowledge and plural value.

10.5 Judgment in Application-Dominant Praxis

Section 10.4 developed practical problem formation as a selective and revisable articulation of consequential conditions within a wider practical situation. The present section examines the judgments through which such a problem acquires practical orientation. Its role is to clarify how application-dominant praxis moves from a problem formulation toward assessments of significance, urgency, acceptability, and possible response while knowledge remains incomplete and values can remain heterogeneous. The objective is to preserve the distinct functions of aesthetic, epistemic, normative, and practical judgment while explaining how they interact within consequential action. The discussion therefore proceeds from four judgment forms to three composite practical assessments, then examines conflict, the historical formation of practical taste, and revisability. The method is conceptual and relational. Judgment is treated as historically formed, position-sensitive, evidence-constrained, normatively accountable, and open to revision rather than as either an unstructured intuition or a mechanically determined output.

Chapter 6 already developed judgment within research-dominant praxis and later extended aesthetic and normative conditions across the wider field of praxis in Sections 145 and 159 of Chapter 6. The present section inherits that architecture from the standpoint of application-dominant praxis. Its additional concern is the closure-bearing function of judgment when consequences can no longer be deferred entirely to further inquiry. Aesthetic judgment can orient attention and form; epistemic judgment evaluates what is sufficiently warranted; normative judgment evaluates what is permissible, valuable, fair, or responsible; practical judgment organizes a provisional orientation among possible responses. These functions can interact closely without becoming interchangeable.

Definition 10.78 (Application-dominant judgment configuration). *An application-dominant judgment configuration is the historically and relationally situated combination of aesthetic, epistemic, normative, and practical evaluations through which a practical problem is interpreted and a consequential orientation is provisionally organized under uncertainty, value plurality, temporal pressure, and distributed effects.*

Definition 10.78 treats judgment as a configuration rather than a single score. Different judgment forms answer different evaluative demands. Their interaction can support action, delay, inquiry, redesign, withdrawal, monitoring, or preservation of

options. Their disagreement can itself become practically informative.

Table 10.5 summarizes the distinct objects, functions, and non-substitution constraints of the four principal judgment forms together with the composite assessments of significance, urgency, and acceptability. The table is an analytical map rather than a sequence: application-dominant praxis can move recursively among these judgments as new evidence, values, consequences, and options become salient.

10.5.1 Aesthetic Judgment

Aesthetic judgment enters application-dominant praxis wherever form, coherence, fit, atmosphere, legibility, rhythm, simplicity, symbolic resonance, or experiential organization influences how a practical possibility is perceived and inhabited. Its role extends beyond decorative preference. A public environment can communicate care, dignity, exclusion, surveillance, openness, or institutional distance through its spatial organization. A technical interface can make a relation intelligible or obscure it. A procedure can exhibit a coherence that supports participation, or a friction that reveals unresolved practical mismatch. A proposed intervention can also appear elegant because it connects several constraints through a compact architecture.

Section 159 of Chapter 6 introduced aesthetic conditions of application. Within the present chapter, the emphasis moves toward judgment under practical consequence. Application-dominant praxis frequently encounters possibilities whose full effects remain unavailable in advance. Formal evidence can compare some properties while leaving experiential, symbolic, spatial, or relational qualities only partly articulated. Aesthetic judgment can help detect such qualities and can preserve possibilities that established metrics would otherwise overlook.

Definition 10.79 (Aesthetic practical judgment). An *aesthetic practical judgment* is a provisional evaluation of the formal, experiential, symbolic, spatial, temporal, or relational qualities through which a practical option appears coherent, fitting, legible, inhabitable, compelling, discordant, or generatively promising within a specified situation.

Aesthetic practical judgment can precede complete conceptual decomposition. An experienced practitioner can perceive that an intervention “does not fit” a setting before the relevant institutional or relational friction has been fully specified. A community can experience an apparently efficient facility as alienating even when conventional performance indicators remain favorable. A design team can recognize that a cumbersome arrangement contains too many points of dependency before failure probabilities have been estimated. Such responses can function as signals for investigation, comparison, redesign, or preservation.

Their evidential status nevertheless requires discipline. A felt coherence can reflect genuine structural integration, familiar convention, professional training, prestige, or inherited style. Aesthetic fluency can make an intervention appear more trustworthy than its evidence warrants. Conversely, unfamiliar or heterogeneous arrangements can appear disorderly because they depart from established practical taste. Aesthetic judgment therefore contributes most responsibly when its orienting role remains traceable and open to epistemic and normative examination.

Proposition 10.80 (Aesthetic orientation under application). *Aesthetic judgment can legitimately orient attention, exploratory selection, design refinement, and experiential evaluation in application-dominant praxis, while the practical authority of the resulting*

Table 10.5: Judgment forms and composite assessments in application-dominant praxis.

Judgment form	Primary object	Practical function	Scope boundary
Aesthetic	Form, fit, coherence, legibility, experiential quality, generative appeal	Orients attention, design, intelligibility, inhabitation, and exploratory selection	Aesthetic force cannot establish truth, permissibility, or overall practical adequacy.
Epistemic	Claims, mechanisms, representations, consequences, uncertainty	Assesses warrant, reliability, scope, and residual uncertainty relevant to action	Evidential support alone cannot determine ends or distribute burdens legitimately.
Normative	Values, rights, responsibilities, fairness, burdens, benefits, recognition	Assesses permissibility, priority, obligation, and evaluative legitimacy	Normative desirability cannot establish causal efficacy or empirical likelihood.
Practical	Response orientation within a concrete situation	Organizes a provisional course of action, inquiry, delay, restraint, or revision	Practical closure should preserve the distinct grounds and residual conflicts that support it.
Significance	Materiality of the problem and its consequences	Orders attention according to depth, extent, persistence, affected positions, and generative effects	Significance should remain distinct from temporal urgency and institutional visibility.
Urgency	Time sensitivity of consequences and option change	Assesses the cost of delay, timing constraints, and windows for reversible response	Organizational pressure or salience alone does not establish practical urgency.
Acceptability	Admissibility of an option within the relevant value and risk configuration	Establishes whether an option can enter or remain within the practically supportable response set	Acceptability is distinct from optimality and can remain contested across affected positions.

orientation depends on its relation to epistemic warrant, normative conditions, affected positions, and anticipated consequences.

The proposition preserves a distinctive place for aesthetic judgment without con-

verting aesthetic attraction into a universal criterion. Its practical contribution lies partly in making form and experience available for judgment before they are fully represented by established measures.

10.5.2 Epistemic Judgment

Epistemic judgment in application-dominant praxis concerns what can responsibly be treated as sufficiently warranted for a consequential purpose. The relevant object can include the practical situation, the problem formulation, causal or generative mechanisms, anticipated consequences, the reliability of indicators, the transferability of prior evidence, the behavior of models, and the uncertainty surrounding all of these. The principal difference from research-dominant judgment lies in practical orientation: the question is often whether the available knowledge is adequate for a particular action, delay, pilot, restriction, or monitoring arrangement rather than whether inquiry has reached a disciplinary endpoint.

Definition 10.81 (Application-oriented epistemic judgment). *An application-oriented epistemic judgment is a provisional assessment of the warrant, reliability, scope, relevance, uncertainty, and decision sensitivity of the knowledge used to organize consequential praxis within a specified practical situation.*

Decision sensitivity matters because uncertainty can be practically material even when it is modest in abstract statistical or evidential terms. A small uncertainty concerning a reversible and low-consequence action can have limited influence on orientation. The same degree of uncertainty can become decisive when consequences are severe, highly distributed, difficult to reverse, or concentrated on actors with limited capacity to absorb error. Epistemic adequacy for application is therefore partly relation-dependent.

Application also changes the evidential threshold problem. Further inquiry can sometimes reduce uncertainty, but it consumes time and can allow ongoing consequences to continue. Action can itself generate evidence while changing the system from which that evidence is produced. A pilot, staged implementation, reversible trial, or monitoring arrangement can therefore operate simultaneously as practical response and epistemic strategy. These possibilities do not remove uncertainty; they alter its structure and its practical consequences.

Proposition 10.82 (Purpose-sensitive epistemic sufficiency). *Epistemic sufficiency for application depends on the relation among evidential warrant, the contemplated practical orientation, consequence severity, reversibility, timing, affected positions, and the availability of further inquiry rather than on a context-free evidential threshold.*

Proposition 10.82 anticipates the more detailed treatment of decision thresholds in Section 272. Its present function is to keep epistemic judgment distinct from a general demand for maximal certainty. Application-dominant praxis requires explicit attention to what kind of knowledge is sufficient for which kind of practical commitment.

10.5.3 Normative Judgment

Normative judgment evaluates the value-laden dimensions of practical orientation. It concerns permissibility, obligation, fairness, responsibility, recognition, priority, acceptable burden, distribution of benefit and risk, and the values that an intervention

may protect, transform, or undermine. Such judgment becomes structurally unavoidable once practical closure affects multiple positions or future possibilities.

Definition 10.83 (Normative practical judgment). *A normative practical judgment is a provisional evaluation of the permissibility, priority, fairness, responsibility, desirability, or evaluative legitimacy of a practical orientation relative to the values, rights, vulnerabilities, relations, and consequences materially implicated in the situation.*

Normative judgment enters before the final choice of action. Problem boundaries already influence which harms, values, and affected positions become visible. Evidence standards can distribute risk between those who demand action and those who bear the consequences of waiting. Participation procedures influence whose reasons enter the decision. Monitoring arrangements determine which consequences remain detectable after implementation. Normativity therefore participates throughout application-dominant praxis rather than appearing only after a technically preferred option has been identified.

Value plurality complicates normative judgment without making it indeterminate. Some conflicts can be reduced by redesign, sequencing, compensation, option preservation, or additional participation. Some values can be locally compared within a shared practical context. Other conflicts can remain partially irreducible. In such cases, the task of judgment includes making the basis of provisional priority visible and preserving the disagreement for later review.

Normative judgment also has a temporal dimension. Present beneficiaries and future affected positions can differ. Immediate relief can create later dependency. A burden accepted during an emergency can become normalized after the emergency passes. A decision that appears fair under one institutional arrangement can become unequal after capacities diverge. Application therefore requires normative judgments whose horizon extends beyond the moment of implementation.

Proposition 10.84 (Normative traceability in application). *When a practical orientation materially depends on normative commitments, the relevant values, affected positions, burden and benefit relations, and basis of provisional priority should remain sufficiently explicit for contestation, accountability, and later revision.*

This proposition prepares later sections on participation, responsibility, and justice. Its immediate role is to prevent normative commitments from disappearing inside apparently technical criteria.

10.5.4 Practical Judgment

Practical judgment occupies a different functional position from the preceding judgment forms. Aesthetic, epistemic, and normative judgments evaluate particular dimensions of a practical situation or option. Practical judgment organizes these differentiated assessments into a provisional orientation under the constraints of action. It therefore has a closure-bearing function without requiring complete convergence among the judgments that support it.

Definition 10.85 (Practical judgment). *A practical judgment is the situated and revisable evaluation through which application-dominant praxis provisionally organizes an orientation among action, inquiry, delay, restraint, sequencing, monitoring, redesign, withdrawal, or other consequential responses in light of the materially relevant epistemic, normative, aesthetic, temporal, institutional, and capability condi-*

tions.

Definition 10.85 avoids treating practical judgment as a weighted sum whose components must share a common metric. The decision can involve threshold conditions, incomparable values, hard constraints, asymmetric risks, uncertain causal relations, and institutional duties. Some considerations can rule out an option; others can support a preference among remaining options; still others can justify additional inquiry or preserve multiple options. Practical judgment can therefore possess a structured architecture without becoming reducible to a single optimization procedure.

Practical judgment also concerns the level of commitment. A situation can support a full intervention, a limited pilot, a temporary measure, a reversible trial, a monitoring period, a consultation process, or a decision to preserve option value while gathering information. The practical conclusion is therefore broader than “act” or “do nothing.” It can specify a sequence, a degree of reversibility, a review condition, and the responsibilities attached to implementation.

Proposition 10.86 (Differentiated integration of judgment). *Practical judgment should integrate materially relevant judgment forms while preserving their distinct grounds, because practical closure can be warranted despite residual disagreement and can become distorted when strength in one judgment form is silently substituted for weakness in another.*

An intervention can be aesthetically coherent, epistemically plausible, and institutionally feasible while remaining normatively unacceptable. A normatively compelling end can coexist with weak evidence concerning the proposed mechanism. An intervention supported by strong evidence can remain practically unsuitable when local capacity is absent or the action cannot be implemented at the required time. Practical judgment keeps these differences visible while still allowing orientation to occur.

10.5.5 Judgment of Significance

Once a practical problem has been formed, application-dominant praxis must assess how much practical weight it should receive relative to other demands. This assessment concerns significance. Significance is broader than salience because prominence can arise from visibility, novelty, institutional attention, media concentration, professional convention, or recent disruption. A condition with limited immediate visibility can nevertheless possess substantial long-horizon or cross-scale significance.

Definition 10.87 (Practical significance judgment). *A practical significance judgment is a provisional assessment of the material importance of a practical problem, relation, consequence, or possible response relative to its depth, extent, persistence, affected positions, cross-scale effects, and capacity to alter later possibilities.*

Several dimensions can contribute to significance. Depth concerns how substantially a condition affects relevant capabilities, relations, or states. Extent concerns how widely consequences are distributed. Persistence concerns duration and recurrence. Positional significance concerns whether burdens fall on actors with distinctive vulnerability, responsibility, or dependence. Generative significance concerns whether the condition changes future capacities, institutions, relations, or option spaces. Cross-scale significance concerns whether local effects propagate into wider structures or whether large-scale conditions become concentrated in

particular sites.

These dimensions need not move together. A narrowly distributed burden can be severe. A mild present disturbance can become significant because it creates a reinforcing trajectory. A widely visible event can be transient. A slow institutional change can have limited immediate salience while altering future possibilities across a long horizon. Practical significance judgment therefore benefits from multidimensional specification rather than a single intuitive impression of importance.

Proposition 10.88 (Significance beyond salience). *Practical significance should be assessed through the consequence structure of the problem and its future generative effects rather than inferred directly from current visibility, institutional attention, or experienced intensity alone.*

The proposition also protects quieter positions. Actors with limited voice can bear consequences that receive little organizational salience. Historical arrangements can normalize burdens until they cease to appear exceptional. Significance judgment therefore connects problem formation to later analysis of participation, power, and justice.

10.5.6 Judgment of Urgency

Urgency is the temporal dimension of practical judgment. Section 10.2 introduced urgency as part of the principal contradiction of application-dominant praxis. The present subsection specifies urgency as an evaluative judgment concerning how delay changes consequences, available options, reversibility, and the conditions of later action.

Definition 10.89 (Practical urgency judgment). *A practical urgency judgment is a provisional assessment of the time sensitivity of a practical problem or response based on how delay, acceleration, sequencing, or missed windows are expected to alter consequences, option spaces, affected relations, or reversibility.*

Urgency therefore differs from significance. A highly significant problem can unfold slowly enough to permit extended inquiry and participation. A locally limited problem can become urgent because a short window exists for preventing irreversible harm. The two judgments can reinforce one another, but neither can substitute for the other.

Urgency also differs from pressure. Administrative deadlines, public attention, political cycles, contractual schedules, and organizational anxiety can create demands for speed. Some of these demands correspond to genuine practical time constraints; others mainly reflect institutional rhythms. Conversely, practical urgency can remain weakly visible when those most affected lack access to agenda-setting institutions. Judgment should therefore reconstruct the temporal consequence pathway rather than equating urgency with the loudest request for immediate action.

Proposition 10.90 (Consequence-sensitive urgency). *Urgency should increase in practical weight when delay materially worsens plausible consequences, forecloses valuable options, reduces reversibility, or weakens future capacity to respond, while the source and distribution of the temporal constraint remain open to examination.*

A sound urgency judgment can also support deliberate slowing. Where rapid commitment would foreclose safer alternatives, a short delay can preserve option value. Where ongoing harm compounds quickly, delay can itself become the more conse-

quential intervention. Urgency judgment therefore concerns the temporal architecture of response rather than a general preference for speed.

10.5.7 Judgment of Acceptability

Practical orientation also requires an assessment of acceptability. Acceptability concerns whether an option can reasonably enter or remain within the set of supportable responses given the relevant normative commitments, epistemic conditions, risks, capabilities, institutional responsibilities, affected positions, and possibilities for revision. It is a threshold concept rather than a synonym for superiority.

Definition 10.91 (Practical acceptability judgment). *A practical acceptability judgment is a provisional assessment of whether a contemplated response satisfies the materially relevant conditions required for legitimate and responsible consideration within the current practical situation.*

Acceptability can depend on multiple kinds of condition. Some can operate as hard constraints, such as a binding legal prohibition, a basic safety requirement, or the absence of minimum implementation capacity. Others can operate through thresholds that vary with consequence and reversibility. Still others can depend on participation, distribution, compensation, monitoring, or the availability of exit and repair. An option can therefore become acceptable through redesign even when its original form was unsuitable.

Acceptability also differs from optimality. Under incomplete knowledge, several options can remain acceptable without a justified basis for declaring one uniquely best. Conversely, an option that scores highly on a chosen performance metric can remain unacceptable because it violates a responsibility, imposes concentrated irreversible harm, or excludes a materially affected position from a decision where participation is required. Practical judgment should therefore avoid importing an optimization result as if it already contained the full architecture of admissibility.

Definition 10.92 (Practical acceptability region). *A practical acceptability region is the provisionally bounded set of response orientations that satisfy the currently applicable epistemic, normative, institutional, capability, risk, participation, and reversibility conditions strongly enough to remain eligible for practical selection or further development.*

The region can change as the situation changes. New evidence can remove an option. Improved capacity can make a previously infeasible response available. Participation can reveal an unrecognized burden. Redesign can reduce risk. An emergency can alter acceptable tradeoffs while creating obligations to review those tradeoffs after the emergency. Acceptability is therefore relational and temporally indexed.

Proposition 10.93 (Acceptability before preference). *Where materially relevant threshold conditions exist, application-dominant praxis should distinguish the judgment that an option is practically admissible from the later judgment that it is provisionally preferred among admissible alternatives.*

This distinction prepares Section 271, where available, latent, foreclosed, and generated actions are developed more explicitly.

10.5.8 Conflict among Forms of Judgment

Application-dominant praxis commonly contains disagreement among judgment forms. An intervention can be epistemically well supported and normatively contested. A normatively urgent end can lack a sufficiently reliable mechanism. An aesthetically coherent design can be inaccessible to some users. An operationally feasible response can preserve immediate stability while narrowing future options. These conflicts are part of the practical structure rather than noise surrounding an otherwise singular criterion.

Definition 10.94 (Inter-judgment conflict). An *inter-judgment conflict* occurs when materially relevant aesthetic, epistemic, normative, or practical evaluations support incompatible assessments of significance, urgency, acceptability, priority, or response within the same practical situation.

The first analytical task is localization. A disagreement can concern evidence, causal mechanism, value, scale, time horizon, affected population, responsibility, feasibility, or acceptable risk. Different conflicts invite different responses. Additional inquiry can reduce some epistemic conflicts. Redesign can reconcile some practical and normative tensions. Participation can reveal missing reasons or clarify distributional disagreement. Sequencing can reduce conflict between urgency and deliberation. Other conflicts remain genuinely plural after clarification.

Definition 10.95 (Judgment conflict record). A *judgment conflict record* is a traceable account of materially unresolved disagreement among judgment forms, including the object of disagreement, affected positions, evidential basis, normative grounds, temporal horizon, practical implications, and the basis of any provisional priority adopted for action.

Recording conflict matters because practical closure can otherwise create an appearance of convergence that never occurred. A decision can be reasonable under conditions of unresolved disagreement, especially when delay also carries consequences. The legitimacy of that closure depends partly on whether the disagreement was recognized, whether its practical implications were considered, and whether routes for review remain available.

Proposition 10.96 (Conflict-preserving closure preparation). *When materially relevant judgment forms remain in conflict after proportionate inquiry and deliberation, preparation for practical closure should preserve the unresolved grounds of disagreement and the reasons for provisional priority rather than represent the resulting orientation as evaluatively unanimous.*

The proposition connects directly to the later treatment of practical closure in Section 281. It also makes disagreement a source of future information: later consequences can illuminate which judgment was more sensitive to aspects of the situation that were previously uncertain or weakly represented.

10.5.9 Historical Formation of Practical Taste

Judgment occurs through historically formed dispositions. Section 159 of Chapter 6 defined practical taste as the historically formed disposition through which some questions, representations, values, or forms of action appear especially fitting, credible, serious, elegant, urgent, or worthy. Application-dominant praxis requires this concept because practical judgment frequently relies on forms of recognition that

precede complete explicit reasoning.

Professional communities develop senses of what counts as a credible intervention, an acceptable risk, a serious problem, a competent design, a realistic timetable, or an institutionally workable compromise. Communities affected by repeated interventions can develop equally important practical repertoires concerning trust, danger, burden, and the difference between formal provision and usable access. Institutions accumulate procedures, precedents, templates, and tacit expectations. These histories shape the field within which options first appear plausible.

Definition 10.97 (Application-oriented practical taste). *Application-oriented practical taste* is the historically formed disposition through which actors, communities, or institutions experience practical problems, evidence, risks, designs, temporal demands, and possible responses as more or less fitting, credible, serious, workable, or worthy of commitment.

Practical taste can compress experience. A practitioner can recognize a familiar failure pattern from subtle relational cues. A community can anticipate that a nominally inclusive procedure will reproduce exclusion because it resembles earlier arrangements. An institution can know that a technically attractive design exceeds its maintenance capacity. Such judgments can contain knowledge that formal models have not yet represented.

The same historical formation can preserve inherited blind spots. Institutional familiarity can normalize burdens. Professional aesthetics can privilege solutions legible within a discipline while marginalizing other forms of knowledge. Repeated emergency practice can make exceptional restrictions feel ordinary. A successful past intervention can become a template even after the surrounding relations have changed. Practical taste therefore benefits from provenance and contestability.

Definition 10.98 (Practical taste provenance). *Practical taste provenance* is the reconstructable history of training, experience, institutional routine, cultural repertoire, prior success and failure, affected-position knowledge, and inherited convention through which a practical disposition has acquired authority within a field of application.

Making provenance visible neither invalidates tacit expertise nor guarantees its adequacy. It creates a basis for comparing experience with evidence, examining whose histories shaped the disposition, and identifying conditions under which the inherited practical taste may require revision.

10.5.10 Revisability of Practical Judgment

Practical judgment is provisional because the situation, evidence, values, capabilities, institutions, and consequences can change. Revisability therefore belongs to the architecture of judgment itself. It should be designed before failure whenever the consequence structure makes revision materially important.

Definition 10.99 (Practical judgment revision). *Practical judgment revision* is the traceable reassessment of a provisional practical orientation when materially relevant evidence, relations, affected positions, value configurations, capabilities, consequences, or available actions change the conditions that supported the earlier judgment.

Revision can occur at several levels. An epistemic revision changes what is

believed about the situation, mechanism, or consequence. A normative revision changes the evaluation of burdens, benefits, responsibilities, or values. An aesthetic revision changes the experienced fit, coherence, legibility, or symbolic meaning of an intervention. A practical revision changes the orientation among action, delay, inquiry, sequencing, withdrawal, or redesign. These revisions can occur independently or together.

Consequences generated by action are especially important. An intervention can reveal relations that were previously inaccessible, generate new constituencies, alter capacities, change expectations, create dependencies, or transform the value landscape. Success according to an initial objective can therefore coexist with reasons for revising the original judgment. Application-dominant praxis should retain enough traceability to distinguish changed evidence from changed values, changed conditions, and changed practical possibilities.

Definition 10.100 (Judgment revision condition). *A judgment revision condition is a specified class of evidential, relational, normative, institutional, temporal, or consequential change whose material occurrence is sufficient to reopen one or more components of an earlier practical judgment for reassessment.*

Revision conditions need not imply continuous reopening. Stable coordination can itself possess practical value, and some decisions require durable expectations. The relevant design problem concerns the relation between stability and corrigibility. Higher consequence, lower reversibility, greater uncertainty, weaker participation, or stronger dependence can justify more explicit monitoring and lower thresholds for review. Routine low-consequence decisions can support lighter revision architectures.

Proposition 10.101 (Revisability as practical capacity). *The quality of application-dominant judgment depends partly on the capacity to recognize materially changed conditions, preserve the provenance of earlier judgments, and reopen orientation when their supporting configuration has been transformed.*

The judgment architecture developed in this section completes the movement from practical problem formation toward practical orientation. Aesthetic, epistemic, and normative judgments preserve distinct evaluative functions; practical judgment organizes their relation under consequential conditions; significance, urgency, and acceptability provide composite assessments relevant to response; conflict preserves unresolved plurality; practical taste locates judgment historically; and revisability prevents provisional orientation from becoming insulated from later evidence and consequence.

The next section turns from the architecture of judgment to the objects toward which judgment is directed: the ends of action and the practical orientations through which heterogeneous values acquire provisional direction. Section 270 therefore develops ends, competing values, means–ends relations, generative and future value, value conflict, and the revisability of ends without presuming that application-dominant praxis begins from a single fixed objective.

10.6 Ends and Practical Orientation

Section 10.5 developed the judgment architecture through which a practical problem acquires significance, urgency, acceptability, and a provisional orientation toward

response. The present section examines the ends toward which such orientation is organized. Its role is to clarify how application-dominant praxis selects, combines, contests, and revises valued directions without assuming that practical value can be reduced to a single metric or fixed independently of history and relation. The objective is to distinguish ends from values, means, consequences, and future generative conditions while preserving the ways in which these elements co-constitute one another in practice. The discussion proceeds from ends of action and plural forms of value to competing ends, means–ends relations, intrinsic and instrumental value, generative value, future value, value conflict, and revisability of ends. The method is conceptual and relational. Ends are treated as historically situated practical orientations whose content, priority, feasibility, and legitimacy can change as situations, knowledge, affected positions, and consequences change.

Application-dominant praxis requires more than recognition of what matters. It must organize a direction of movement within a concrete situation. A practical problem can be highly significant while supporting several reasonable ends. A value can be widely affirmed while leaving its operational meaning contested. An intervention can advance one valued condition while weakening another. A means can reshape the end it was selected to serve. An immediate improvement can also transform the future conditions under which later value can be generated. The architecture of ends must therefore preserve plurality, temporal extension, relational consequence, and revision.

Definition 10.102 (Practical end). A *practical end* is a provisionally specified valued condition, direction, relation, capability, process, or transformation toward which application-dominant praxis organizes consequential action within a defined situation and temporal horizon.

Definition 10.103 (Practical orientation). A *practical orientation* is the structured relation among practical ends, relevant values, admissible means, temporal horizons, affected positions, uncertainty, and revision conditions through which praxis acquires direction before a specific action is selected.

Definitions 10.102 and 10.103 separate the end from the wider architecture that gives it practical meaning. An end can be expressed compactly, such as increasing access, reducing exposure, preserving a habitat, maintaining continuity, strengthening a capability, or repairing a damaged relation. Practical orientation additionally asks whose access, which exposure, what habitat, whose continuity, which capability, what relation, across what duration, under which constraints, with what distribution of burdens, and under what conditions the end itself should be reconsidered.

Table 10.6 presents ends as one component of a wider practical architecture. The dimensions interact, yet their distinctions remain analytically useful. In particular, plural value does not by itself specify an end; an end does not by itself identify an admissible means; a selected means does not exhaust the consequence structure; and a present objective does not exhaust the future conditions created through action.

10.6.1 Ends of Action

An end of action gives practical direction to a situation that has already been interpreted through problem formation and judgment. Ends can concern states, relations, capacities, processes, distributions, institutional arrangements, forms of recognition, or trajectories. Some are comparatively determinate, such as restoring a damaged

Table 10.6: Analytical dimensions of ends and practical orientation.

Dimension	Primary object	Practical question	Characteristic revision trigger
End	Valued direction or condition	What condition, relation, capability, process, or transformation is praxis organized toward?	Change in problem formulation, affected positions, feasibility, or legitimacy
Value plurality	Heterogeneous grounds of worth	Which forms of value are materially relevant, and how are they expressed?	Newly recognized values, positions, scales, or modes of evaluation
Competing ends	Incompatible or tension-bearing directions	Which ends can coexist, which require sequencing, and which generate substantive conflict?	New tradeoffs, redesigned options, altered priorities, or changed constraints
Means–ends relation	Intervention and intended direction	How do selected means enable, reshape, defer, or transform the end?	Means-generated side effects, dependency, institutional change, or goal displacement
Intrinsic and instrumental value	Modes of valuation	Which objects or relations are valued in themselves, through their contribution, or through both relations?	Context change, revised interpretation, or altered consequence structure
Generative value	Conditions of future valued generation	Which relations, capacities, and processes expand or sustain later possibilities for valued generation?	Evidence of capture, depletion, exclusion, fragility, regeneration, or transformed capability
Future value	Delayed and future-facing consequences	Which future conditions, subjects, option spaces, and irreversible effects enter present orientation?	Changed horizon, new forecasts, emergent subjects, or updated reversibility assessment
Value conflict	Incompatible evaluative commitments	Where do values diverge, and what form does the conflict take?	Deliberation, participation, redesign, changed evidence, or consequence
Revision	Orientation over time	Under which conditions should ends or their priority be reformulated?	Material change in knowledge, value, capability, consequence, authority, or context

service to a specified level. Others are directional, such as strengthening resilience, widening participation, protecting dignity, sustaining ecological regeneration, or increasing a community's capacity to govern a shared resource. The level of specifica-

tion should match the practical situation rather than follow a universal template.

Ends are also position-sensitive. The same nominal end can have different meanings for differently situated subjects. “Improving access” can refer to physical availability, affordability, linguistic intelligibility, legal eligibility, temporal convenience, technological compatibility, social safety, or effective capability to use what is formally available. A practical end becomes more determinate when the relevant relations and affected positions are made explicit.

Definition 10.104 (End specification). An *end specification* is the traceable articulation of a practical end through its relevant subjects or positions, valued condition, relational scope, spatial and temporal horizon, degree of attainment, uncertainty, and conditions for later revision.

Specification does not require complete precision at the outset. Application-dominant praxis often begins with a directional end whose operational meaning develops through inquiry, participation, trial, and consequence. Excessively early precision can freeze categories that remain under dispute. Excessively loose formulation can conceal disagreement or make later evaluation indeterminate. The appropriate degree of specification is therefore itself a practical judgment.

Ends can be layered. A near-term end can stabilize a deteriorating condition; an intermediate end can rebuild capability; a longer-horizon end can alter the relations that repeatedly reproduce the problem. These layers can support one another, yet temporal layering can also conceal tension. A stabilization measure can create dependency. A rapid protective intervention can narrow later participation. A long-horizon transformation can impose burdens during transition. End specification should therefore include the relation among temporal layers rather than list them as independent aspirations.

Proposition 10.105 (Relational specification of ends). *The practical adequacy of an end specification increases when it identifies the relations, affected positions, temporal horizons, and consequence pathways through which attainment would acquire practical meaning within the relevant situation.*

Proposition 10.105 does not imply that every end can be fully formalized. It establishes a discipline of practical articulation. A valued direction becomes more governable when the relations through which it matters are visible enough to support judgment, participation, accountability, monitoring, and revision.

10.6.2 Plural Forms of Value

Practical ends arise within fields of heterogeneous value. Application-dominant praxis can involve welfare, dignity, autonomy, safety, beauty, ecological integrity, continuity, care, truthfulness, recognition, participation, trust, capability, cultural meaning, institutional legitimacy, efficiency, learning, resilience, and many other forms of worth. Their relevance varies by situation. Some can be measured through common units for limited purposes; others remain qualitatively distinct. Some are articulated explicitly; others become visible through conflict, experience, loss, or encounter.

Definition 10.106 (Practical value form). A *practical value form* is a situated mode through which a condition, relation, capability, process, experience, or consequence is regarded as worthy of preservation, realization, expansion, repair, restraint, or

protection within application-dominant praxis.

The phrase “value form” is used here at the generalized GR level. It identifies heterogeneity in what matters without yet constructing the substantive economic theory of heterogeneous value developed in later Parts of the book. This distinction allows Chapter 10 to establish a trans-domain praxis architecture while leaving specifically economic questions of valuation, conversion, circulation, return, and capture to the GRE-specific analysis.

Plurality enters in several ways. Distinct actors can hold different values. The same actor can hold several values that become difficult to reconcile in a particular situation. A single value term can contain different interpretations across communities. Values can also operate at different scales: an intervention can improve individual convenience while weakening collective continuity, or support present security while reducing ecological resilience over a longer horizon. Practical plurality therefore concerns more than disagreement among persons.

Definition 10.107 (Value plurality profile). A *value plurality profile* is a situated account of the materially relevant value forms within a practical problem, including their bearers or affected positions, modes of expression, scales, temporal horizons, potential compatibilities, and known areas of tension.

A value plurality profile supports analysis without requiring commensuration. It can identify which values are jointly satisfiable, which depend on different temporal horizons, which are vulnerable to exclusion by a chosen metric, and which require explicit normative judgment. Quantification can remain valuable where a defensible metric exists. The plural architecture simply prevents that metric from silently becoming a complete representation of worth.

Proposition 10.108 (Plural value preservation). *When materially relevant values remain heterogeneous, practical orientation should preserve their distinct grounds long enough to identify genuine compatibility, conversion, conflict, or residual incommensurability before closure.*

This proposition is methodological as much as normative. Premature aggregation can erase information about who gains, who bears burdens, which values change form, and which losses resist compensation. Preserving plurality creates a more informative basis for later judgment and decision.

10.6.3 Competing Ends

Plural value can produce several plausible ends within the same practical situation. These ends may reinforce one another, coexist with limited interaction, compete for scarce capacity, or become substantively incompatible. Application-dominant praxis therefore requires an account of end competition that is richer than a ranked list of objectives.

Definition 10.109 (Competing practical ends). *Competing practical ends* are two or more valued practical directions whose simultaneous pursuit generates material tension through incompatible conditions, scarce capacities, divergent temporal demands, unequal distribution of consequences, or conflicting normative commitments.

Competition can arise through resource use, but it can also arise through relation, timing, institutional attention, or identity. A rapid emergency response can compete

with inclusive deliberation because time is scarce. Strong standardization can compete with local adaptability because the same institutional architecture cannot fully maximize both. Expansion of one capability can alter dependencies that another end seeks to reduce. Preservation of continuity can compete with transformation where inherited arrangements carry both valued meaning and reproduced harm.

End competition can also be generated by scale. A local intervention may produce benefits within the target setting while shifting burdens to another site. A short-horizon success can weaken a long-horizon objective. An institution can meet its formal mandate while creating coordination costs for a wider system. Identifying these relations requires tracing consequence beyond the immediate unit of action.

Definition 10.110 (End-compatibility profile). An *end-compatibility profile* records the known relations among practical ends, including reinforcement, conditional compatibility, sequencing requirements, competition, displacement, and substantive incompatibility across relevant scales and horizons.

An end-compatibility profile can reveal opportunities for redesign. Some conflicts reflect the current action architecture rather than the values themselves. Sequencing, modular intervention, differentiated provision, compensatory arrangements, or expanded capacity can make previously competing ends more compatible. Other conflicts remain substantive after redesign and require explicit judgment about priority, burden, and responsibility.

Proposition 10.111 (Conflict localization among ends). *Before practical priority is assigned among competing ends, application-dominant praxis benefits from locating whether the tension arises primarily from value disagreement, scarce capacity, temporal sequencing, institutional design, scale, distribution, or the current representation of available action.*

Conflict localization matters because different sources of competition call for different responses. A design conflict may be mitigated through redesign. A capacity conflict can motivate capability expansion. A temporal conflict can invite sequencing. A genuine value conflict may require deliberation and explicit practical closure while preserving dissent.

10.6.4 Means and Ends

The relation between means and ends is generative. Means do more than transport praxis toward a pre-existing objective. They create experiences, dependencies, capacities, institutions, habits, categories, and future possibilities while they are being used. These changes can alter the meaning or desirability of the original end. Application-dominant praxis therefore treats means and ends as analytically distinguishable yet dynamically coupled.

Definition 10.112 (Means–ends coupling). *Means–ends coupling* is the relational process through which the instruments, procedures, institutions, technologies, and forms of coordination selected to pursue an end also shape the content, feasibility, distribution, interpretation, and future revision of that end.

A participatory process can change what participants understand the desired end to be. A technology chosen for efficiency can create maintenance dependencies that alter the practical meaning of autonomy. A temporary administrative procedure can become institutionally durable and thereby reshape later expectations. A coercive

means can damage trust that the nominal end requires for long-term realization. Conversely, a means designed to build capability can make a more ambitious end feasible over time.

Means also carry normative properties. A desired outcome can be pursued through procedures that distribute voice, burden, exposure, and authority differently. Practical evaluation therefore includes the pathway of action, rather than treating consequences at the terminal point as the sole object of value. This is particularly important where the process itself affects dignity, recognition, consent, trust, or future agency.

Proposition 10.113 (Generative means–ends relation). *Where means materially transform relations, capacities, institutions, or future option spaces, their evaluation belongs to the practical orientation itself because those transformations can alter both the attainability and the content of the end.*

This proposition also limits simple means–ends substitution. Two interventions aimed at the same nominal outcome can generate very different relational futures. Their practical comparison therefore extends beyond expected attainment of the immediate target.

Means can become ends in a limited sense when a previously instrumental condition acquires independent value through practice. Participation initially introduced to improve information can come to be valued as a relation of recognition. A capability built to deliver one service can become a broader source of collective agency. Conversely, an end can become instrumental to a wider orientation when its attainment enables later valued possibilities. The categories of means and ends are therefore functional relations within a practical architecture rather than permanent properties of objects.

10.6.5 Intrinsic and Instrumental Value

Application-dominant praxis often distinguishes what is valued in itself from what is valued because it contributes to something else. The distinction remains useful when treated relationally. The same condition can carry intrinsic and instrumental value simultaneously, and its practical role can change across contexts and horizons.

Definition 10.114 (Intrinsic practical valuation). *An intrinsic practical valuation attributes worth to a condition, relation, capability, process, experience, or form of life as an end within the relevant practical horizon, rather than solely through its contribution to another specified end.*

Definition 10.115 (Instrumental practical valuation). *An instrumental practical valuation attributes worth to a condition, relation, capability, process, or resource through its contribution to the realization, protection, expansion, or regeneration of another specified practical end.*

These definitions describe valuation relations rather than metaphysical classes. Trust can be valued for the quality of a relationship and for its contribution to coordination. Knowledge can be valued as understanding and as a basis for safer action. Ecological diversity can be valued as part of a living world and through its contribution to resilience. Institutional transparency can be valued as a relation of accountability and as a means of improving error detection.

The distinction also supports scrutiny of instrumentalization. A relation that has independent value for participants can be treated by an institution solely as a device

for achieving another objective. Participation can become data extraction; care can become a productivity mechanism; education can become only credential production. Practical analysis can reveal such reductions by making the valuation relation explicit.

At the same time, intrinsic valuation does not end practical inquiry. A valued end can still conflict with other valued ends, depend on conditions that are costly to sustain, or change meaning across positions. Treating something as intrinsically valuable establishes one ground of practical importance. It does not automatically determine priority across every situation.

Proposition 10.116 (Plural valuation relations). *A practical object can participate simultaneously in intrinsic and instrumental valuation relations, and application-dominant praxis should preserve these relations separately where their conflation would obscure reasons, dependencies, or consequences relevant to judgment.*

This separation becomes especially useful when a policy, technology, institution, environment, or social relation appears beneficial under one evaluative relation while deteriorating under another.

10.6.6 Generative Value

Application-dominant praxis also encounters value that lies in the capacity of present conditions to participate in later valued generation. A relation, capability, institution, environment, knowledge practice, or material resource can matter partly because it supports the emergence, maintenance, diversification, or regeneration of future possibilities. Chapter 10 uses this idea at the generalized GR level. The later GRE-specific Parts develop the economic theory of generative value, heterogeneous value, conversion, circulation, return, capture, dissipation, and regeneration in greater depth.

Definition 10.117 (Generative practical value). *Generative practical value* is the situated worth attributed to a condition, relation, capability, process, or configuration because of its capacity to enable, sustain, diversify, regenerate, or deepen later possibilities for valued generation across a specified horizon.

Generative practical value differs from a prediction of immediate output. A capability can remain valuable even when its future uses cannot be listed exhaustively. A trusted relation can support later cooperation across problems that have not yet emerged. An ecosystem can sustain forms of regeneration whose future contributions are only partly known. A flexible institution can preserve the capacity to learn and redesign under changing conditions. A body of knowledge can open later questions whose significance is invisible at the moment of investment.

The concept therefore draws attention to enabling conditions and option structures. It asks whether action preserves or expands the capacity for later valued generation, who can access that capacity, and which relations govern its use. It also asks whether present gains depend on depletion, capture, exclusion, or fragility that weakens later generation. A highly productive intervention in the short term can have low or adverse generative value if it exhausts the relational or material conditions that make future production, learning, care, adaptation, or cooperation possible.

Definition 10.118 (Generative value horizon). *A generative value horizon* is the spatial, temporal, relational, and subject-relevant range across which the capacity of a present configuration to support later valued generation is assessed.

The horizon matters because generative effects can be redistributed. An arrangement can expand one group's option space while narrowing another's. It can increase local capability while externalizing maintenance burdens. It can generate rapid innovation while concentrating control over the infrastructure required for later participation. Generative value therefore requires attention to access, distribution, dependency, and governance rather than only to aggregate possibility.

Proposition 10.119 (Generative orientation of practical ends). *Where present action materially changes the conditions of later agency or valued generation, practical orientation should evaluate both the immediate end and the generative conditions that the selected pathway is likely to create, preserve, distribute, or erode.*

The proposition does not make generativity the single master value. Some harmful processes are highly generative in the descriptive sense that they reproduce themselves and create further effects. Practical value enters only through a specified evaluative relation. Generative practical value therefore remains one dimension within a plural architecture of judgment.

10.6.7 Future Value

Practical orientation extends across time. Present action can create delayed benefits, cumulative burdens, irreversible losses, new capabilities, future dependencies, altered institutions, or changed option spaces. Future-directed value enters whenever later consequences matter to present judgment even though their exact form remains uncertain.

Definition 10.120 (Future-directed practical value). *Future-directed practical value is the present practical significance attributed to future conditions, relations, capabilities, experiences, option spaces, or subjects whose realization, exposure, or possibility is materially affected by current action.*

Future-directed value includes more than discounted continuation of present preferences. Future subjects can have different needs, technologies, institutions, and value interpretations. Some future possibilities are currently unknown. Present actors can nevertheless recognize responsibilities toward preserving conditions under which later subjects can act, revise, learn, participate, or refuse inherited arrangements.

Temporal asymmetry complicates practical judgment. Present actors can impose durable structures on people who cannot participate in the current decision. Benefits can arrive earlier than burdens. Maintenance responsibilities can persist after the original decision-makers have exited. Damage can become visible only after thresholds are crossed. A future value analysis therefore benefits from distinguishing timing, persistence, reversibility, intergenerational distribution, and the transfer of responsibility.

Definition 10.121 (Future-value profile). *A future-value profile is a situated account of materially relevant delayed benefits, burdens, capabilities, dependencies, option changes, irreversible effects, and affected future positions across the temporal horizons relevant to a practical orientation.*

The profile need not assign a common numerical value to every future consequence. Scenario analysis, qualitative trajectories, thresholds, robustness analysis, and explicit uncertainty can all contribute. The central discipline is to prevent the

present decision horizon from silently defining the horizon of practical value.

Future value also interacts with generative value. Preserving a future condition and preserving the capacity for future generation are related yet distinct concerns. A practical orientation can value a specific future state, such as continued access to a place, while also valuing a more open capability, such as the ability of future participants to redesign how that place is governed. The first concerns a valued future condition; the second concerns the generative capacity through which future value can continue to be formed.

Proposition 10.122 (Temporal extension of practical orientation). *When current action materially alters durable conditions or future option spaces, the relevant practical orientation extends beyond the decision-maker's immediate horizon to include delayed consequences, future affected positions, and the revisability available to later actors.*

This proposition prepares later treatments of irreversibility, long-horizon responsibility, and intergenerational justice without requiring Chapter 10 to resolve those questions in advance.

10.6.8 Value Conflict

Value conflict occurs when materially relevant forms of worth support incompatible practical orientations after reasonable clarification of the situation. Such conflict can arise within one actor, among actors, across institutions, between present and future positions, or among scales. It can also arise because different values respond to different aspects of the same relation. Application-dominant praxis requires conflict to be represented explicitly enough that closure does not masquerade as evaluative unanimity.

Definition 10.123 (Practical value conflict). *A practical value conflict occurs when two or more materially relevant value forms support incompatible ends, priorities, burdens, permissions, or response orientations within the same practical situation and the incompatibility persists after clarification of factual misunderstanding and available redesign.*

The definition separates value conflict from disagreements that can be reduced through better evidence. Two groups can appear to disagree about values while actually relying on different empirical beliefs about consequences. Conversely, shared evidence can leave a genuine conflict over acceptable risk, recognition, autonomy, distribution, continuity, or responsibility. Locating the source of disagreement matters for determining whether further inquiry, deliberation, redesign, compensation, sequencing, or explicit priority judgment is appropriate.

Value conflicts also differ in structure. Some concern priority among values that all parties recognize. Some concern the interpretation of a shared value. Some concern whether a proposed value should carry practical standing at all. Some arise from unequal power to make a value legible within an institution. Others arise because a conversion framework treats one value as compensable in terms of another while affected subjects reject that conversion.

Definition 10.124 (Value-conflict map). *A value-conflict map is a traceable representation of the values, affected positions, interpretations, conversion assumptions, temporal horizons, distributional consequences, and unresolved normative grounds that structure a practical disagreement.*

A value-conflict map supports practical judgment without promising automatic resolution. It can reveal false conflict, conditional compatibility, hidden distribution, asymmetric standing, or a genuine residual disagreement. In the latter case, practical closure may still be required because action or delay has consequences. The closure should then preserve the grounds of disagreement, the authority under which priority was assigned, and the conditions under which the decision may be reviewed.

Proposition 10.125 (Conflict-preserving end selection). *Where a practical end is selected under unresolved value conflict, the orientation should preserve the materially relevant grounds of disagreement, the affected positions, the basis of provisional priority, and the revision conditions associated with that priority.*

This proposition parallels the conflict-preserving judgment architecture of Section 10.5. It also prepares later analysis of participation, accountability, and justice, where the authority to define and prioritize values becomes part of the practical problem itself.

10.6.9 Revisability of Ends

Ends can require revision because the practical situation evolves. New evidence can change the expected consequence structure. Participation can reveal an affected position that the original end omitted. An intervention can generate capacities that make a more ambitious end feasible. An emergency end can lose priority after stabilization. A long-standing institutional objective can become misaligned with the conditions from which it originally arose. Revisability therefore belongs to practical orientation from the beginning rather than appearing only after failure.

Definition 10.126 (End revision). *End revision* is the traceable reformulation, reprioritization, expansion, contraction, sequencing, suspension, or retirement of a practical end in response to materially changed knowledge, values, affected positions, capabilities, constraints, consequences, authority, or temporal conditions.

End revision differs from simple implementation adjustment. Changing a delivery mechanism while preserving the valued direction can be a revision of means. Changing who counts as an affected subject, what condition is sought, how values are prioritized, or which future horizon governs the decision constitutes a deeper revision of orientation. Distinguishing these levels supports accountability because a project can otherwise claim continuity while its effective purpose has shifted substantially.

Definition 10.127 (End revision record). *An end revision record* is a traceable account of the prior end, the evidence and judgments that supported it, the conditions that triggered reconsideration, the values and positions implicated by the change, the revised orientation, residual disagreement, and the consequences expected from the revision.

Revisability should also preserve practical continuity. Constantly changing ends can make coordinated action impossible, erode trust, and prevent learning from sufficiently stable interventions. The relevant architecture therefore combines commitment with reopening conditions. An end can remain stable while uncertainty is monitored, and revision can be triggered when specified thresholds or qualitative changes become material.

Definition 10.128 (End-revision condition). *An end-revision condition* is a specified evidential, normative, relational, institutional, temporal, or consequence-related

change whose occurrence is sufficient to reopen the current practical orientation for reconsideration.

Typical revision conditions can include evidence that the intended end is unattainable under current relations, discovery of serious unrepresented burdens, transformation of the underlying problem, emergence of a materially affected group, erosion of legitimacy, creation of new capabilities, crossing of an irreversibility threshold, or evidence that the pursuit of one end is destroying the conditions required for other protected values.

Proposition 10.129 (Commitment with revisability). *Application-dominant praxis can combine practical commitment with revisability by specifying ends strongly enough to coordinate action while preserving explicit conditions under which their content, priority, or continuation should be reconsidered.*

This proposition completes the transition from judgment to action architecture. Section 10.5 established how a practical orientation can become supportable under heterogeneous judgments. The present section has specified the valued directions, conflicts, temporal extensions, and revision conditions through which such orientation acquires content. The next task is to examine the set of actions through which these ends can be pursued. Section 271 therefore turns to the *action space*: available actions, latent actions, foreclosed actions, generated actions, constraints, capacities, unequal practical possibility, and the expansion or contraction of what can be done.

10.7 Action Space

Section 10.6 developed the ends and practical orientations through which application-dominant praxis acquires valued direction. The present section turns from practical orientation to the structure of practical possibility. Its role is to clarify how a situated actor, institution, collective, or distributed configuration encounters a field of actions that is neither fixed in advance nor reducible to a list of formally imaginable alternatives. The objective is to distinguish actions that are presently available, latent, foreclosed, or generated; to specify how constraints and capacities shape their practical reachability; and to examine how action spaces differ among positions and change through praxis. The discussion proceeds from available actions to latent, foreclosed, and generated actions, then analyzes constraints, capacities, unequal action spaces, expansion, and contraction. The method is relational and dynamic. Action space is treated as a historically formed, position-sensitive, and revisable configuration whose structure can itself become an object of intervention.

Practical orientation does not determine what can be done. An end can be normatively compelling while remaining institutionally unreachable. A technically feasible intervention can remain unavailable to actors who lack authority, resources, coordination, or access. A response that appears absent from an initial menu can become possible after learning, alliance formation, institutional redesign, technological development, or recombination of existing capacities. Conversely, prior commitments, deteriorating conditions, lost capabilities, legal changes, or irreversible transformations can remove options that once existed. Application-dominant praxis therefore requires an account of possibility that distinguishes imagination from reachability and current reachability from future generability.

Definition 10.130 (Practical action space). *A practical action space is the historically*

and relationally situated configuration of actions, response sequences, commitments, delays, withdrawals, coordination forms, and option-preserving moves that can be meaningfully considered or made reachable by a specified actor or distributed agency configuration within a defined practical situation, temporal horizon, and set of capacities and constraints.

The definition deliberately treats an action space as structured rather than merely enumerated. Actions can differ in cost, accessibility, authority requirements, reversibility, timing, informational demands, coordination burden, and consequences for later options. Some can be undertaken immediately. Some require preparatory action. Some become reachable only through collective organization. Some are formally permitted yet practically inaccessible. Some appear available only because burdens have been displaced onto actors whose capacities are absent from the decision frame. A practically useful action space must therefore represent more than nominal alternatives.

Definition 10.131 (Effective action space). An *effective action space* is the subset and relational structure of a practical action space whose elements are reachable, activatable, or realistically generable under the capacities, constraints, authority relations, temporal conditions, information, and coordination arrangements materially relevant to the present stage of praxis.

Definition 10.131 distinguishes effective possibility from nominal possibility. An organization can possess a formal power that cannot be exercised within the required time. A person can possess a legal entitlement that remains unusable because access conditions are prohibitive. A collective can lack any single actor with sufficient capacity while possessing a realizable option through coordination. These differences matter because practical judgment becomes distorted when the apparent choice set is detached from the relational conditions that make choice effective.

Table 10.7 summarizes the principal dimensions of action-space analysis developed in this section. The categories are analytically distinct while remaining dynamically connected. A latent action can become available; an available action can become foreclosed; an earlier intervention can generate a new action; and expansion for one position can coincide with contraction for another.

10.7.1 Available Actions

Available actions form the most immediately visible region of a practical action space. They include interventions, coordination moves, information-gathering activities, temporary measures, reversible trials, withdrawals, pauses, or commitments that can be activated under presently recognized conditions. Availability is therefore relational and time-indexed. An action can be available to one actor and unavailable to another; available today and unavailable after a deadline, available formally and inaccessible materially, or available only if several actors coordinate.

Definition 10.132 (Available practical action). An *available practical action* is an action or response sequence that a specified actor or distributed agency configuration can presently activate within the relevant temporal horizon using materially accessible capacities, permissions, relations, information, and coordination arrangements.

Availability contains several dimensions. Material availability concerns access to physical, financial, technological, spatial, or ecological conditions required for action. Institutional availability concerns authority, permission, jurisdiction, procedural ac-

Table 10.7: Analytical dimensions of practical action space.

Dimension	Primary condition	Practical significance	Characteristic transition
Available action	Present reachability	Identifies responses that can be activated within current capacities, authority, access, and time	Loss or gain of resources, permission, coordination, information, or timing
Latent action	Potential reachability	Preserves options that require discovery, recombination, preparation, or relation formation	Learning, coordination, reinterpretation, mobilization, or capability development
Foreclosed action	Lost or blocked reachability	Makes visible options removed by prior commitment, constraint, degradation, exclusion, or elapsed time	Repair, institutional change, renewed access, or irreversible loss
Generated action	Praxis-created possibility	Identifies actions that become possible because earlier action changes capability, relation, knowledge, or institution	Capacity formation, infrastructure, trust, learning, alliance, or rule change
Constraint	Restriction on activation or reachability	Specifies where practical possibility is narrowed and through which relation	Relaxation, substitution, displacement, intensification, or removal
Capacity	Enabling condition for action	Specifies who can activate which possibilities and under what conditions	Acquisition, coordination, maintenance, transfer, erosion, or capture
Inequality	Positional difference in reachability	Reveals asymmetry in effective options, costs, exit possibilities, and option preservation	Redistribution of capability, authority, burden, or access
Expansion	Enlargement or deepening of reachable possibility	Can increase adaptability, agency, experimentation, and future revisability	New capacities, relations, institutions, knowledge, resources, or preserved options
Contraction	Reduction of reachable possibility	Can protect valued constraints or intensify dependence, vulnerability, and lock-in	Prohibition, depletion, commitment, coercion, loss, or deliberate narrowing

cess, and organizational compatibility. Epistemic availability concerns whether actors possess enough knowledge to identify and enact the option. Relational availability concerns whether necessary cooperation, trust, representation, or coordination can be mobilized. Temporal availability concerns whether the option can be activated before its practical window closes.

These dimensions can diverge. A technically straightforward action can remain institutionally unavailable. A legally authorized action can remain materially infeasible. A well-resourced institution can possess the means to act yet lack the relational legitimacy needed for cooperation. A response can be available in principle while its preparation time exceeds the interval in which it would matter. Application-dominant praxis should therefore avoid treating the formal menu of options as equivalent to the effective action space.

Definition 10.133 (Availability profile). An *availability profile* is a traceable account of the material, institutional, epistemic, relational, temporal, and coordination conditions that determine whether a candidate action is presently reachable and at what practical cost.

The cost component is important because extreme activation costs can make nominal availability practically misleading. An actor can technically exit a relation while doing so would destroy access to essential resources. A community can formally participate in a procedure while participation requires time, language, travel, or expertise unavailable to many members. A public body can possess emergency authority whose use would consume institutional trust or narrow later cooperation. Effective availability therefore includes the burdens required to exercise an option.

Available actions also possess different degrees of reversibility and commitment. Some preserve later choice; others commit resources, establish precedents, create dependencies, or alter relations before their ultimate consequences become known. Availability alone does not establish desirability. It identifies a reachable region that later decision analysis must evaluate through evidence, values, risk, and consequence.

Proposition 10.134 (Situated availability). *The practical availability of an action depends on the situated relation among actor position, capacity, authority, access, coordination, timing, and activation cost; formal permission or abstract feasibility alone is therefore insufficient to establish effective availability.*

Proposition 10.134 links action-space analysis to the practical-situation architecture of Section 10.3. What can be done is partly a property of the situation as reconstructed from a particular position. A change in situation can change availability even when the nominal action remains conceptually unchanged.

10.7.2 Latent Actions

Practical possibility often exceeds the set of actions visible at the moment of decision. Some options are latent because the required elements already exist but have not yet been connected. Others require modest capability development, institutional interpretation, alliance formation, knowledge acquisition, or reconfiguration of existing resources. Latency is therefore a form of potential reachability rather than simple absence.

Definition 10.135 (Latent practical action). A *latent practical action* is an action or response configuration that is not presently available in effective form yet can become reachable through plausible recombination, preparation, learning, coordination, reinterpretation, resource mobilization, or capability development within the relevant practical horizon.

Latent actions matter because an apparently narrow choice set can reflect limited

search rather than genuine structural necessity. An institution can perceive only established procedures while adjacent organizations possess complementary capabilities. A local group can lack formal authority while being able to create a coalition that changes access. A technical intervention can appear infeasible until an existing infrastructure is repurposed. A conflict framed as a binary choice can acquire additional options after the underlying ends are decomposed and recombined.

The recognition of latency nevertheless requires discipline. An imagined action becomes practically relevant only when the pathway from current conditions to reachability is sufficiently plausible. Vague appeals to future innovation, unspecified coordination, or hypothetical resources can inflate the action space and conceal present constraints. Latent action analysis should therefore identify the intermediate transformations required for activation.

Definition 10.136 (Activation pathway). An *activation pathway* is a specified sequence of preparatory changes through which a latent action could become available, including the capacities, relations, permissions, knowledge, resources, time, and coordination required at each materially relevant stage.

An activation pathway can itself contain branching possibilities. Initial inquiry can reveal that an assumed constraint is weaker than expected. A pilot can generate knowledge needed for wider implementation. Negotiation can create permission. Training can create capability. Infrastructure repair can reopen an option. In this sense, some practical actions are best understood as pathways whose early stages alter the later action space.

Latency also has an epistemic dimension. Actors cannot deliberately select an option they have not recognized. Problem formulation, comparative analysis, historical reconstruction, participation, simulation, analogy, and aesthetic exploration can all reveal options that were previously outside the active decision frame. The expansion of recognized possibility can therefore precede any material change in capacity.

Proposition 10.137 (Latent-option preservation). *When plausible latent actions could materially improve future practical orientation, early-stage praxis should preserve the capacities, relations, time, and option conditions required for their activation unless stronger practical reasons justify their foreclosure.*

This proposition does not establish a general preference for maximal optionality. Preserving every possibility can be costly or impossible. Its function is narrower: where a latent option may become materially important, application-dominant praxis should recognize the consequences of destroying its activation pathway before the option has been adequately considered.

10.7.3 Foreclosed Actions

Action spaces are shaped as strongly by lost possibilities as by visible ones. An action can be foreclosed because a resource has been depleted, a legal window has closed, a relation has deteriorated, infrastructure has failed, an irreversible commitment has been made, a capability has disappeared, or an institution excludes the actor from the relevant process. Foreclosure therefore records the historical structure of practical possibility.

Definition 10.138 (Foreclosed practical action). A *foreclosed practical action* is an action or response pathway that was previously reachable, plausibly activatable, or

structurally conceivable within the relevant practical field but has become materially unavailable because required capacities, relations, permissions, resources, temporal windows, environmental conditions, or institutional pathways have been removed, exhausted, blocked, or irreversibly transformed.

Foreclosure differs from mere non-selection. An available action that actors decide not to choose remains part of the action space unless the decision itself removes it. Foreclosure also differs from current latency. A latent option retains a plausible activation pathway. A foreclosed option lacks such a pathway under the present configuration, though some forms of foreclosure can later be repaired.

Several forms are analytically useful. Temporal foreclosure occurs when delay closes a window. Material foreclosure follows depletion or destruction of necessary conditions. Institutional foreclosure follows rules, jurisdictional changes, procedural barriers, or exclusion from authority. Relational foreclosure follows collapse of cooperation, trust, access, or recognition. Capability foreclosure follows the loss of skills, infrastructure, knowledge, health, organizational memory, or coordination capacity required for action. Commitment foreclosure occurs when earlier decisions create dependencies, contracts, sunk structures, precedents, or irreversible transformations that remove later alternatives.

Definition 10.139 (Foreclosure profile). *A foreclosure profile is a traceable account of the action possibilities that have become unavailable, the relations and events through which foreclosure occurred, the positions differently affected, the degree of reversibility, and any remaining pathway of repair or substitution.*

Foreclosure profiles are useful because current constraint can otherwise appear natural or inevitable. Historical reconstruction can reveal that a narrow action space was produced through earlier decisions. An institution can appear to possess only one feasible path because alternative capabilities were systematically neglected. A community can appear unable to participate because prior arrangements removed access to information or decision channels. A technical system can appear locked into one architecture because interoperability was abandoned at an earlier stage.

Foreclosure can also be legitimate. Safety rules can remove dangerous options. Rights protections can exclude otherwise feasible forms of coercion. Ecological limits can justify withdrawing destructive pathways. The fact that an option has been closed therefore does not itself indicate injustice or practical failure. Analysis must distinguish protective or normatively justified closure from coercive, accidental, extractive, or capacity-destroying foreclosure.

Proposition 10.140 (Historical legibility of foreclosure). *Where a present action space is materially narrowed by earlier decisions or relational transformations, practical analysis should reconstruct the history of foreclosure sufficiently to distinguish current necessity from historically produced constraint and to identify any remaining possibilities for repair, substitution, or institutional redesign.*

This proposition links action-space analysis to the historical architecture of Sections 10.3 and 10.4. The practical present includes absences whose causes can remain invisible unless lost possibilities are treated as part of the situation.

10.7.4 Generated Actions

Praxis can create possibilities that did not previously exist in usable form. Learning can produce a new technique. Repeated cooperation can generate trust. Institutional reform can create authority. Infrastructure can connect previously separated actors or resources. A pilot can reveal an unanticipated pathway. Collective organization can make an action feasible that no participant could undertake individually. Generated actions therefore express the productive dimension of action-space dynamics.

Definition 10.141 (Generated practical action). A *generated practical action* is an action or response configuration whose practical reachability emerges because prior or ongoing praxis creates, combines, or transforms capacities, relations, knowledge, institutions, resources, authority, infrastructure, or coordination conditions that were previously absent or insufficient.

Generated actions differ from latent actions by degree and pathway. A latent action can often be activated through recombination or preparation within an already sufficient underlying structure. A generated action depends on praxis that substantively changes the structure of possibility. The boundary is contextual, and some options move gradually from latent to generated as preparatory activity becomes constitutive rather than merely activating.

The generative relation can be direct. Training creates a skill; infrastructure creates access; a new legal procedure creates authority. It can also be indirect. A transparent process can generate trust that later permits coordination. A small reversible trial can generate evidence that makes wider adoption supportable. A successful repair can restore confidence and thereby enable a more ambitious intervention. A conflict-resolution process can generate a relation through which future problems can be addressed differently.

Definition 10.142 (Action-generating intervention). An *action-generating intervention* is a practical intervention whose relevant consequence includes the creation, strengthening, recombination, or redistribution of capacities and relations that make additional actions reachable at a later stage.

This concept connects action space with the generative practical value developed in Section 10.6. An intervention can be valuable partly because it accomplishes an immediate end and partly because it changes what actors can subsequently do. The two dimensions can diverge. A rapid centralized response can achieve an immediate target while weakening local capability. A slower participatory process can initially accomplish less while generating durable coordination capacity. Neither pattern is universally preferable; their practical significance depends on the situation, values, urgency, and consequence structure.

Generated actions can also widen harmful capability. A technology can create new forms of surveillance. An institution can generate stronger extraction capacity. A coordination infrastructure can improve both care and coercion. Action-space expansion therefore remains normatively ambivalent. The creation of possibility requires judgment about who gains capability, for what purposes, under which governance, and with what consequences for others.

Proposition 10.143 (Generative consequence of action). *When an intervention materially changes later capacities, relations, authority, knowledge, or coordination, evaluation of that intervention should include the action possibilities it generates or removes in addition to its immediate intended outcome.*

Proposition 10.143 prepares later treatment of intervention design. It also reinforces a central GR commitment: action participates in the production of the future field within which later action becomes possible.

10.7.5 Constraints on Action

Constraints delimit practical reachability. Section 10.3 introduced practical constraints within the broader constitution of the practical situation. The present subsection examines them specifically through their effect on action space. A constraint can raise the cost of action, slow activation, require coordination, exclude an option, redirect a pathway, or make one actor dependent on another. Constraint analysis therefore concerns structure rather than a simple inventory of obstacles.

Definition 10.144 (Action constraint). An *action constraint* is a materially relevant relational, institutional, material, epistemic, temporal, normative, ecological, technological, or capability condition that restricts the reachability, timing, scale, form, distribution, or continuation of one or more practical actions for a specified position.

Some constraints are hard within the present horizon. A physical limit, a binding legal prohibition, an exhausted resource, or a missed temporal window can remove an option. Others are soft or transformable. A budget constraint can be relaxed through reallocation. A knowledge constraint can be reduced through inquiry. A coordination constraint can be addressed through organization. An institutional constraint can change through authorization or redesign. The distinction is practical rather than metaphysical because the same condition can be fixed at one horizon and transformable at another.

Constraints can also be coupled. Relaxing one can activate another. Additional funding can expose a shortage of trained personnel. New authority can reveal weak implementation capacity. Faster technical deployment can create participation or legitimacy problems. Increased information can expand the set of recognized options while also increasing coordination burden. Constraint analysis should therefore examine dependency among constraints rather than assume that removal is additive.

Definition 10.145 (Constraint configuration). A *constraint configuration* is the structured relation among the materially relevant constraints affecting a practical action space, including their dependencies, positional distribution, temporal behavior, substitutability, and degree of transformability.

Normative constraints deserve special attention. Rights, duties, safety conditions, ecological limits, professional standards, and protections for affected subjects can restrict action while constituting part of what makes praxis legitimate. Application-dominant praxis should therefore avoid treating every constraint as a defect to be removed. Some constraints preserve valued relations or prevent the action space of one actor from expanding through the domination of another.

The location of a constraint can also differ from the location of its effects. A procurement rule in one institution can determine what local practitioners can do elsewhere. A technical standard can shape access for users who never participated in its design. A funding condition can narrow the action space of organizations downstream. Constraint analysis therefore benefits from tracing the relation through which limitation is transmitted.

Proposition 10.146 (Relational constraint analysis). A *constraint is practically intel-*

ligible when analysis identifies the positions it limits, the relations through which limitation is transmitted, the actions affected, the degree of transformability, and the consequences of relaxing, preserving, or redistributing the constraint.

This proposition prevents the language of constraint from becoming a purely technical vocabulary. A constraint can be materially efficient, normatively protective, politically imposed, historically inherited, or unequally distributed. Its practical role depends on these relations.

10.7.6 Capacities for Action

If constraints narrow action space, capacities make action reachable. Capacity includes more than resources held by an isolated actor. It can reside in skills, knowledge, health, authority, organization, trust, infrastructure, institutional memory, legitimacy, attention, time, communication, representation, coordination, and access to other actors' capabilities. Some capacities are individual; many are relational or collective.

Definition 10.147 (Action capacity). An *action capacity* is a materially relevant ability, resource, relation, permission, competence, infrastructure, organizational arrangement, or coordination capability through which a specified actor or distributed agency configuration can activate, sustain, adapt, or revise practical action.

Capacity is therefore distinct from possession. A resource can exist without being usable. Knowledge can exist without being accessible to the people who must act. Authority can exist without implementation infrastructure. A network can exist without sufficient trust for coordination. An institution can have personnel yet lack time, attention, or procedural flexibility. Effective capacity depends on configuration.

Definition 10.148 (Capacity configuration). A *capacity configuration* is the structured relation among the abilities, resources, permissions, knowledge, relations, infrastructures, and coordination arrangements whose combination determines which actions can be initiated, sustained, adapted, and reviewed from a specified practical position.

Capacities can complement one another. Knowledge becomes actionable when paired with authority. Authority becomes effective when paired with implementation capability. Material resources become usable when paired with logistical coordination. Participation becomes consequential when voice is connected to decision pathways. Such complementarity means that increasing one capacity can have little effect when another remains binding.

Capacities also require maintenance. Institutional memory can erode through turnover. Infrastructure can decay. Trust can be depleted by repeated unilateral action. Skills can disappear when they are unused. Emergency capability can weaken during long periods without investment. A practical action space can therefore contract gradually even when formal structures remain unchanged.

Capacity development can itself be an end. An intervention can be designed partly to strengthen the ability of affected actors to respond, learn, coordinate, revise, or govern later situations. This form of capability-oriented praxis is especially important when repeated dependence on external intervention would reproduce vulnerability. Yet capacity development can also redistribute power, create new dependencies, or standardize practices in ways that narrow other forms of agency. Its practical value remains relational and contestable.

Proposition 10.149 (Configured capacity). *The practical effect of a capacity depends on its configuration with complementary capacities, access conditions, authority, relations, maintenance requirements, and the specific actions for which it is relevant.*

Proposition 10.149 supports a move away from aggregate capacity scores when these would obscure practical bottlenecks. Action-space analysis asks which configurations permit which actions for which actors under which conditions.

10.7.7 Unequal Action Spaces

Practical action spaces are distributed unevenly. Actors can face the same nominal situation while possessing very different effective possibilities. One actor can delay with limited cost while another bears immediate harm. One institution can exit a relation while another depends on continued access. One group can transform a rule while another can only adapt to it. One participant can preserve several alternatives while another must commit early because resources are scarce. These differences make action-space inequality a constitutive feature of many practical situations.

Definition 10.150 (Action-space inequality). *Action-space inequality* is a materially relevant difference among actors or positions in the reachability, cost, timing, reversibility, authority, option preservation, exit possibility, or capacity-generation associated with practical action.

Action-space inequality differs from unequal outcomes. Actors can receive similar immediate outcomes while possessing very different abilities to revise, refuse, exit, appeal, or shape what happens next. Conversely, unequal resources do not always translate directly into unequal practical possibility if institutions redistribute authority, provide collective capability, or protect access. The relevant object is the structured field of what different positions can effectively do.

Several dimensions are important. Reach inequality concerns the number and diversity of accessible options. Cost inequality concerns the burden required to activate them. Temporal inequality concerns who can afford to wait and who faces immediate thresholds. Reversibility inequality concerns who can recover after a failed choice. Voice inequality concerns who can alter the collective action space. Exit inequality concerns who can withdraw without catastrophic loss. Generative inequality concerns whose actions create future capabilities and whose actions mainly consume scarce options.

Definition 10.151 (Positional action-space profile). *A positional action-space profile* is a comparative representation of the available, latent, and foreclosed actions, activation costs, constraints, capacities, reversibility, exit possibilities, and option-preservation conditions associated with a specified practical position.

Comparing positional profiles can reveal asymmetries hidden by a single aggregate action set. A collective decision can appear to offer three options while only one is realistically available to vulnerable participants. A formal right to refuse can coexist with material dependence that makes refusal prohibitively costly. A consultation can offer voice while leaving participants unable to affect implementation. Such patterns connect action-space analysis to later sections on power, participation, responsibility, and justice.

Action-space inequality also changes the meaning of consent and choice. A decision selected from a severely constrained set can remain intentional while reflecting de-

pendence or structural limitation. Practical analysis should therefore preserve both agency and constraint rather than reducing constrained choice either to full voluntariness or to complete absence of agency.

Proposition 10.152 (Positional comparison of practical possibility). *Where consequential action depends on actors with materially unequal capacities, dependencies, or exit conditions, the practical action space should be analyzed positionally so that nominally shared options do not conceal unequal reachability, activation cost, reversibility, or capacity to shape later possibilities.*

This proposition gives action-space inequality a diagnostic role. It does not by itself determine what redistribution is justified. It makes the asymmetry visible for the later judgments of power, participation, responsibility, and justice.

10.7.8 Expansion of Action Space

Application-dominant praxis can seek to expand practical possibility. Expansion can occur by creating resources, knowledge, authority, infrastructure, coordination, trust, institutional pathways, skills, representation, or time. It can also occur by reducing activation costs, reopening foreclosed pathways, preserving reversible options, or making latent actions visible. Expansion therefore concerns the structure and quality of possibility, not only the number of nominal choices.

Definition 10.153 (Action-space expansion). *Action-space expansion* is a practical transformation that increases the reachability, diversity, quality, reversibility, adaptability, or distributive accessibility of materially relevant actions for one or more positions within a specified horizon.

The definition includes quality because a larger choice set can remain practically poor. Ten inaccessible options do not necessarily provide more agency than two robust ones. Expansion can be especially significant when it introduces qualitatively different pathways, creates an exit option, reduces dependency, increases reversibility, or enables affected actors to participate in shaping future action.

Expansion can take several forms. Capacity expansion increases what actors can implement. Epistemic expansion increases what they can recognize and evaluate. Institutional expansion creates new channels of authorization or contestation. Relational expansion creates coordination possibilities. Temporal expansion preserves time for deliberation or staged action. Reversibility expansion lowers the cost of learning from error. Generative expansion builds conditions through which additional possibilities can emerge later.

Definition 10.154 (Action-space expansion profile). An *action-space expansion profile* is a traceable account of which practical possibilities have become newly reachable or more robust, for which positions, through which capacities or relations, at what cost, across what horizon, and with what consequences for others' action spaces.

The final clause is essential because expansion is relationally distributed. Greater discretion for one actor can reduce protection for another. Expanded institutional authority can narrow local autonomy. Greater technological capability can increase both service capacity and surveillance capacity. Additional exit options for powerful actors can transfer risk to those who remain. Expansion should therefore be assessed together with its distribution and governance.

Practical orientation can also value option preservation independently of immedi-

ate use. A reversible intervention can keep several future pathways open. Modular design can reduce lock-in. Diverse capabilities can improve adaptation under uncertainty. Maintaining institutional redundancy can appear inefficient under stable conditions while preserving response capacity under disruption. These forms of expansion connect directly to decision-making under incomplete knowledge because uncertainty can increase the value of preserving future revision.

Proposition 10.155 (Qualified action-space expansion). *Action-space expansion becomes a practically relevant achievement when it improves materially valuable reachability, adaptability, reversibility, or distributed agency without relying on unexamined contraction, burden transfer, or domination elsewhere in the practical field.*

Proposition 10.155 avoids treating freedom of action as a simple maximand. The relevant question concerns the kind of possibility created, its distribution, its governing relations, and its contribution to the practical ends identified in Section 10.6.

10.7.9 Contraction of Action Space

Action spaces also contract. Contraction can follow resource depletion, institutional closure, time pressure, capability loss, coercion, path dependence, infrastructure failure, ecological degradation, conflict, surveillance, dependence, or irreversible commitment. It can also be deliberately produced through safety rules, rights protections, ecological limits, professional standards, or collective agreements that exclude actions judged unacceptable. The practical meaning of contraction therefore depends on what is removed, from whose action space, through which authority, and with what consequences.

Definition 10.156 (Action-space contraction). *Action-space contraction* is a practical transformation that reduces the reachability, diversity, quality, reversibility, adaptability, or distributive accessibility of materially relevant actions for one or more positions within a specified horizon.

Contraction can be abrupt or cumulative. A prohibition can immediately remove an option. A series of minor commitments can gradually create lock-in. Repeated underinvestment can erode capability until an action becomes infeasible. A deteriorating relation can progressively raise coordination costs. Environmental damage can remove future uses long after the original action. The temporal form of contraction matters because gradual losses can remain less visible than discrete decisions.

Definition 10.157 (Contraction pathway). *A contraction pathway* is the sequence of decisions, omissions, relational changes, capability losses, institutional transformations, material degradations, or temporal thresholds through which previously available or latent actions become more costly, less reversible, or practically foreclosed.

Contraction can sometimes be protective. Prohibiting a dangerous practice can reduce one actor's action space while preserving the safety and agency of others. Establishing a right can remove previously available forms of interference. Ecological constraints can withdraw destructive uses in order to preserve future generative capacity. Practical analysis should therefore distinguish *protective narrowing* from *deprivational contraction*. The first deliberately removes actions because their availability threatens protected values or others' agency. The second reduces practical possibility through loss, exclusion, domination, degradation, or capability erosion.

A contraction can also shift rather than eliminate possibility. Restricting one path-

way can stimulate alternative methods. Removing a harmful option can generate incentives for redesign. Conversely, a protective rule can become excessively rigid and eliminate valuable adaptive capacity. The analysis therefore requires attention to substitute pathways and to whether affected actors retain meaningful means of revision, appeal, or collective redesign.

Definition 10.158 (Action-space transition record). *An action-space transition record is a traceable account of materially relevant expansions, contractions, generated possibilities, and foreclosures, including their causal or constitutive relations, affected positions, authority basis, distributional effects, and implications for future revisability.*

Such a record makes action-space change available for accountability and learning. It can reveal that an intervention succeeded according to its immediate outcome while leaving affected actors with fewer future options. It can also reveal that a restrictive intervention created protective conditions that later widened meaningful agency. The same immediate action can therefore have different practical significance when evaluated through the action space it leaves behind.

Proposition 10.159 (Action-space consequence principle). *Where consequential praxis materially changes what actors can later do, refuse, revise, coordinate, or recover from, those changes in action space belong to the consequence structure of the intervention and should remain visible in practical evaluation and reopening decisions.*

The present section has developed action space as a dynamic relational structure rather than a fixed menu of alternatives. Available actions identify present reachability; latent actions preserve potential reachability; foreclosed actions reveal lost possibility; generated actions show how praxis creates new pathways; constraints and capacities shape the effective field; positional analysis reveals unequal practical possibility; and expansion and contraction track how action transforms the future space of action itself. This architecture prepares the next problem without selecting among the possibilities it has identified. Section 272 therefore turns to *decision under incomplete knowledge*: the conditions under which one or more actions can become sufficiently supportable for provisional commitment while uncertainty remains materially unresolved.

10.8 Decision under Incomplete Knowledge

Section 10.7 developed the action space within which application-dominant praxis operates, including available, latent, foreclosed, and generated possibilities and the unequal capacities through which those possibilities become reachable. The present section examines the transition from practical possibility to provisional commitment when knowledge remains incomplete. Its role is to specify the epistemic and practical conditions under which an action, sequence, restraint, or further inquiry can become sufficiently supportable for decision without treating uncertainty as eliminated. The objective is to distinguish epistemic sufficiency, residual uncertainty, decision thresholds, precaution, urgency, delay, provisional decision, robustness, and revisability as related but analytically distinct components of decision under incomplete knowledge. The discussion is conceptual and relational. Decision is treated as a situated practical commitment whose warrant depends on the consequences at stake, the positions affected, the quality and limits of available knowledge, the structure of the action space,

and the capacity to monitor and revise what follows.

Application-dominant praxis rarely reaches a point at which every materially relevant relation is known, every consequence is predictable, every value conflict is settled, and every affected position is represented. A requirement of complete knowledge would therefore convert epistemic humility into practical paralysis. An unrestricted willingness to decide under ignorance would create the opposite failure by detaching action from warranted understanding. The practical problem lies between these poles. Praxis requires a standard of knowledge sufficient for the decision at hand, together with an explicit account of what remains uncertain and how that uncertainty should alter the form, scale, timing, monitoring, and revisability of commitment.

Definition 10.160 (Decision under incomplete knowledge). A *decision under incomplete knowledge* is a situated practical commitment made while one or more materially relevant features of the problem, action space, consequence structure, affected positions, or future conditions remain uncertain, partially observed, contested, or open to revision.

The definition does not identify incomplete knowledge with arbitrary choice. A decision can be strongly warranted while residual uncertainty remains. Conversely, abundant information can fail to support a decision when it is poorly matched to the action, omits affected relations, or leaves decisive mechanisms unresolved. The relevant question concerns the relation between what is known and what the contemplated commitment can generate.

Table 10.8 presents decision as a layered practical architecture rather than a single moment of choice. The dimensions are mutually dependent. Epistemic sufficiency is judged relative to a threshold; the threshold depends partly on urgency, reversibility, and consequence; precaution changes the form of exposure; delay can generate knowledge while also creating costs; robustness concerns the stability of practical support; and revisability governs what happens when the decision encounters a changing field. No single dimension substitutes for the others.

10.8.1 Epistemic Sufficiency for Action

Epistemic sufficiency concerns the amount and quality of knowledge required for a specific practical commitment. The standard is action-relative. A low-cost reversible probe can be supportable under a thinner evidential basis than an irreversible intervention affecting many subjects across a long horizon. A familiar intervention in a stable setting can require different knowledge from an unfamiliar intervention near a possible threshold. A narrow administrative adjustment can depend on different evidence from a structural transformation that changes institutions, capabilities, or future action spaces. Sufficiency therefore cannot be defined independently of what is to be done.

Definition 10.161 (Epistemic sufficiency for action). *Epistemic sufficiency for action* is the condition in which the available warranted knowledge, together with an explicit account of its limits, is adequate to support a specified practical commitment at its proposed scale, duration, reversibility, distribution, and consequence profile.

The definition treats sufficiency as relational rather than absolute. The same body of knowledge can be sufficient for one commitment and insufficient for another. Evidence supporting a small trial can fail to justify population-wide implementation.

Table 10.8: Analytical dimensions of decision under incomplete knowledge.

Dimension	Practical function	Primary question	Characteristic adjustment
Epistemic sufficiency	Relates available knowledge to a contemplated commitment	Is the present knowledge adequate for this action, scale, horizon, and consequence structure?	Additional inquiry, narrower scope, staged action, stronger monitoring, or abstention
Residual uncertainty	Makes unresolved conditions visible	Which uncertainties remain materially relevant after the present inquiry?	Classification, sensitivity analysis, contingency planning, participation, or explicit uncertainty retention
Decision threshold	Specifies a level of support required for commitment	How strong must the practical warrant be before this action becomes admissible?	Threshold change with stakes, reversibility, urgency, distribution, and alternatives
Precaution	Governs exposure where serious consequence remains uncertain	Which protections, limits, or option-preserving measures are warranted before wider commitment?	Reversible trial, protective constraint, modularity, monitoring, or reduced exposure
Urgency	Relates timing to consequence	How does the cost of waiting alter the decision problem?	Faster inquiry, staged commitment, temporary protection, or accelerated review
Delay	Uses time as a practical and epistemic resource	Can waiting materially improve orientation without imposing greater consequential loss?	Information acquisition, consultation, preparation, or time-bounded deferral
Provisional decision	Converts warranted orientation into bounded commitment	What can be committed now, for how long, at what scale, and under which review conditions?	Scope limits, expiration, monitoring, rollback, and reopening criteria
Robustness	Tests support across plausible variation	Does the decision remain supportable across materially plausible assumptions, models, and conditions?	Option redesign, diversification, contingency, or preference for less fragile pathways
Revisability	Preserves correction after commitment	What changes should trigger reconsideration, modification, suspension, or withdrawal?	Review rules, trigger conditions, provenance, and authority for revision

Knowledge adequate for a temporary protective measure can be inadequate for permanent institutional closure. Evidence sufficient to choose among several reversible

procedures can be insufficient to justify foreclosing alternatives whose loss would be difficult to repair.

Epistemic sufficiency also depends on the kinds of uncertainty that remain. A precisely estimated average effect can coexist with poor knowledge of distribution across affected positions. A well-understood immediate mechanism can coexist with uncertainty about long-term institutional adaptation. Strong quantitative evidence can coexist with unresolved category problems. Rich local understanding can coexist with uncertain transfer to another setting. A decision standard focused only on aggregate confidence can therefore miss the dimension of ignorance most relevant to consequence.

Practical sufficiency should also be distinguished from theoretical completeness. An intervention can be supportable before the entire generative structure is known when the relevant mechanism is sufficiently bounded, the downside is limited, monitoring is strong, and revision remains available. Conversely, theoretical sophistication can fail to produce practical sufficiency if the model omits implementation capacity, affected subjects, institutional conditions, or distributional consequences.

Definition 10.162 (Decision-relevant knowledge). *Decision-relevant knowledge* is warranted knowledge whose content bears materially on the admissibility, selection, timing, scale, sequencing, monitoring, or revision of a contemplated practical commitment.

This concept helps avoid an accumulation model of evidence. More information does not always improve decision quality. Some additional information is redundant, weakly connected to the decision, or too slow to matter. Other information can be decisive because it changes whether a vulnerable group is exposed, whether an action is reversible, whether a critical constraint has been misidentified, or whether a supposedly available option is actually unreachable. Inquiry should therefore be oriented partly by the practical consequences of being wrong about particular features of the situation.

Proposition 10.163 (Action-relative epistemic sufficiency). *Epistemic sufficiency should be assessed relative to the contemplated commitment, the consequences of error, the affected positions, the available alternatives, and the capacity for detection and revision rather than by a context-independent quantity of evidence.*

Proposition 10.163 establishes a bridge between epistemology and practical judgment without reducing one to the other. Evidence remains subject to epistemic standards, yet the amount and type of knowledge required for action depend on the practical structure within which that evidence will be used.

10.8.2 Residual Uncertainty

A decision supported by sufficient knowledge can still contain material uncertainty. Residual uncertainty is the uncertainty that remains after the inquiry judged feasible and proportionate for the current decision stage has been conducted. Its presence is normal in application-dominant praxis. The practical requirement is to keep it visible enough that commitment can be shaped around it.

Definition 10.164 (Residual practical uncertainty). *Residual practical uncertainty* is materially relevant uncertainty that remains after the current cycle of inquiry, interpretation, participation, and model assessment has reached its provisional epistemic

stopping point for a specified decision.

Residual uncertainty can concern parameters, mechanisms, boundaries, categories, implementation, institutional response, behavioral adaptation, future conditions, affected positions, value interpretation, interaction among interventions, or the possibility of previously unrecognized consequences. These forms should not be treated as interchangeable. A narrow parameter range can sometimes be handled through sensitivity analysis. Uncertainty about who is affected can require broader participation. Uncertainty about the problem boundary can require reframing. Uncertainty about system response can favor smaller or more reversible interventions. Uncertainty about normative interpretation can require deliberation rather than more measurement.

The distribution of uncertainty also matters. Decision-makers can experience low uncertainty about organizational feasibility while affected communities experience high uncertainty about safety, access, or long-term consequences. Technical experts can understand a mechanism while lacking knowledge of local implementation relations. Local actors can understand situated effects while lacking visibility into system-wide constraints. A residual uncertainty profile should therefore record whose uncertainty is represented and whose knowledge has been excluded or remains difficult to access.

Definition 10.165 (Residual uncertainty profile). *A residual uncertainty profile is a traceable account of the materially relevant uncertainties remaining at a decision point, including their object, source, affected positions, temporal horizon, practical significance, detectability, and possible means of reduction or containment.*

Some residual uncertainty can be reduced before action. Some can be learned only through action. Some cannot be substantially reduced within the relevant horizon. The third case is especially important because a demand for further evidence can become performative delay without changing the practical uncertainty that matters. A mature decision architecture therefore distinguishes reducible uncertainty from uncertainty that must be governed through precaution, robustness, option preservation, monitoring, or explicit acceptance.

Unknown unknowns create a further limit. A residual uncertainty profile can document recognized uncertainty; it cannot enumerate what has not entered the field of recognition. This limitation strengthens the importance of heterogeneity in participation, anomaly detection, reversible design, and reopening conditions. These practices do not reveal every unknown in advance. They can increase the capacity to detect and respond when unexpected manifestations emerge.

Proposition 10.166 (Visibility of residual uncertainty). *Where residual uncertainty remains materially relevant to a consequential decision, its object, distribution, and practical treatment should remain visible in the decision record rather than being absorbed into a single statement of confidence.*

The proposition protects uncertainty from disappearing at the moment of commitment. A decision can be warranted and still carry unresolved epistemic obligations.

10.8.3 Decision Thresholds

A decision threshold specifies how strong the practical warrant must become before a contemplated commitment is treated as admissible. Threshold language can suggest

a single numerical boundary. In application-dominant praxis, many thresholds are composite. They can include minimum evidential support, acceptable uncertainty, procedural conditions, participation requirements, capability readiness, reversibility conditions, and protections for affected positions. Their structure should match the decision rather than imitate a universal decision rule.

Definition 10.167 (Decision threshold). A *decision threshold* is a provisionally specified set of epistemic, practical, normative, institutional, and protective conditions that a contemplated commitment should satisfy before it becomes admissible for action at a given scale and horizon.

Thresholds can be asymmetric. The support required to initiate a reversible pilot can differ from the support required to make the pilot permanent. The support required to pause an intervention after credible evidence of serious harm can differ from the support required to prove the entire causal pathway. The support required to preserve an option can differ from the support required to foreclose it. Such asymmetries can be justified when the consequences of false acceptance and false rejection differ materially.

The threshold should also respond to distribution. A decision whose benefits accrue broadly while severe downside is concentrated on a small group raises a different threshold problem from one whose uncertainty and benefits are similarly distributed. The practical importance of a consequence does not disappear because it affects a minority position. Threshold design should therefore preserve visibility of concentrated burdens and limited exit possibilities.

Thresholds can change through the decision process. New evidence can raise concern. A newly available reversible option can lower the warrant required for learning-oriented action. Deteriorating conditions can increase the cost of waiting. Improved monitoring can make a staged commitment more supportable. A loss of rollback capacity can make the same intervention require stronger prior support. Threshold revision is therefore part of practical reasoning rather than evidence of inconsistency.

Definition 10.168 (Threshold provenance). *Threshold provenance* is the traceable record of why a decision threshold was selected, which consequences and affected positions informed it, which uncertainties it was designed to govern, and what later conditions justify its revision.

A threshold without provenance can appear technical while embedding unexamined value judgments. Threshold provenance makes visible whether a standard was shaped primarily by administrative convenience, safety, rights protection, cost, urgency, professional convention, political authority, or another practical consideration.

Proposition 10.169 (Consequence-sensitive thresholds). *Decision thresholds should vary with the consequence structure of commitment, including scale, reversibility, burden distribution, option foreclosure, urgency, monitoring capacity, and the consequences of both action and non-commitment.*

This proposition does not determine a universal direction of adjustment. High urgency can support earlier protective action while high irreversibility can support stronger prior scrutiny. The practical task is to articulate how these conditions jointly shape the threshold in the specific situation.

10.8.4 Precaution

Precaution governs action when uncertainty remains material and some plausible consequences would be difficult to tolerate, reverse, or repair. It is often misunderstood as a general preference for inaction. Within the present framework, precaution is better understood as a design orientation toward limiting exposure while preserving the capacity to learn and revise.

Definition 10.170 (Precautionary practical orientation). A *precautionary practical orientation* is an approach to consequential action that adjusts commitment, exposure, monitoring, reversibility, participation, or option preservation in response to materially plausible adverse consequences whose probability, pathway, or magnitude remains incompletely known.

Precaution can support several forms of praxis. An intervention can begin at smaller scale. A commitment can be time-limited. A protective constraint can be imposed before wider deployment. A modular design can isolate failure. Monitoring can be intensified. Independent review can be added. A vulnerable group can be excluded from early exposure. A fallback capacity can be retained. Additional alternatives can be preserved while evidence develops. These responses differ from blanket refusal because they seek to govern uncertainty through the structure of action.

Precaution also has costs and distributions. Delaying a beneficial intervention can prolong harm. Restricting an option can protect one group while limiting another's agency. Intensive monitoring can impose surveillance burdens. Maintaining redundant systems can consume scarce capacity. Small trials can shift experimentation onto subjects with less power to refuse. Precaution therefore requires the same relational and normative analysis as other practical orientations.

A further distinction concerns plausibility. Precaution should not be triggered by every imaginable scenario equally. Application-dominant praxis needs a disciplined account of why a consequence is practically plausible, which relations could generate it, and what signs would make it more or less concerning. Where mechanisms are poorly understood, structural analogy, historical cases, early warning manifestations, or vulnerability analysis can still matter, but their epistemic status should remain explicit.

Definition 10.171 (Precautionary burden profile). A *precautionary burden profile* is an account of the protections created by a precautionary measure together with the costs, restrictions, exposures, delays, and distributive effects that the measure imposes on differently situated actors.

Proposition 10.172 (Precaution through action design). *Under material uncertainty, precaution can be expressed through the design of commitment—including scale, sequencing, reversibility, monitoring, protective limits, and option preservation—rather than through a binary choice between unrestricted action and complete inaction.*

This proposition prepares the later treatment of action and non-action in Section 273 and risk in Section 274. The present concern is narrower: precaution changes what counts as a supportable decision under incomplete knowledge.

10.8.5 Urgency

Section 10.5 introduced urgency as a judgment about how timing affects consequence, option space, and reversibility. The present subsection examines its epistemic effect on decision. Urgency compresses the time available for inquiry, consultation, option development, and validation. It can therefore make the search for additional certainty costly. At the same time, rapid action under compressed conditions can increase the chance that consequential assumptions remain unexamined. Urgency changes the decision architecture; it does not make epistemic requirements disappear.

Definition 10.173 (Decision urgency profile). A *decision urgency profile* is a traceable account of how delay over relevant time intervals changes expected harm, opportunity, reversibility, option availability, information value, coordination conditions, and the feasibility of alternative responses.

Urgency can be heterogeneous across components of the same problem. Immediate stabilization can be urgent while structural redesign can remain deliberative. Temporary protection can be urgent while permanent institutional change requires slower participation. A crisis can justify rapid procurement while leaving long-term governance arrangements open. Decomposing urgency prevents a compressed timetable in one component from spreading automatically across the entire practical programme.

Urgency can also change the value of information. When a condition is deteriorating quickly, information arriving after the relevant window can have little practical value. When an early action can preserve time or prevent irreversible loss, the best epistemic strategy can include action that stabilizes the situation while further inquiry continues. Conversely, where a rapid intervention itself creates long-term lock-in, urgency in the presenting problem can increase the importance of distinguishing temporary stabilization from permanent commitment.

Proposition 10.174 (Temporal decomposition of urgent decisions). *Where urgency affects different components of a practical problem unevenly, decision architecture should separate immediate protective or stabilizing commitments from longer-horizon commitments whose evidential, participatory, and revisability requirements remain distinct.*

This proposition preserves both responsiveness and epistemic discipline. It allows praxis to act quickly where timing materially matters while resisting the conversion of emergency timing into a general suspension of review.

10.8.6 Delay

Delay can function as an epistemic resource when additional time permits meaningful learning, consultation, capability development, option generation, or reduction of uncertainty. It can also become a consequential intervention when waiting allows harm to continue, options to disappear, dependencies to deepen, or future action to become more difficult. Decision analysis under incomplete knowledge should therefore treat delay as a temporally structured practical choice rather than as the absence of choice.

The present subsection focuses on the epistemic function of delay. Section 273 will examine delay more broadly within the architecture of action and non-action. Here the question is whether waiting materially improves the warrant or design of a later

decision relative to the consequences created during the waiting period.

Definition 10.175 (Epistemic value of delay). The *epistemic value of delay* is the practical significance of information, interpretation, participation, option development, or capability improvement that can reasonably be obtained through waiting before commitment and that could materially change the admissibility, selection, design, or monitoring of later action.

Not every opportunity for more research creates meaningful epistemic value. Additional studies can repeat known patterns without affecting the decision. Consultation can be prolonged without changing the relevant conflict. Data can become more precise around a quantity whose practical significance remains secondary. Delay is epistemically valuable when the expected learning bears on a live decision margin.

The cost of delay is similarly multidimensional. It can include continuing harm, missed opportunity, declining trust, capability erosion, expiration of legal or seasonal windows, increasing cost, option foreclosure, and transfer of burden to actors with less ability to wait. The ability to delay is itself unequally distributed. An organization with reserves can wait for better information while households, patients, workers, ecosystems, or local institutions absorb the consequences of postponement.

Definition 10.176 (Decision-delay profile). A *decision-delay profile* is an account of the expected learning obtainable through waiting, the consequences produced during that interval, the distribution of those consequences, the options preserved or lost, and the conditions under which delay should end.

Delay can be structured rather than open-ended. A decision can be deferred for a specified period while targeted evidence is collected. A trigger can end delay if a condition worsens. A temporary measure can protect affected subjects while a more consequential decision remains open. A latent option can be activated during the waiting period. These designs convert time into an active component of praxis.

Proposition 10.177 (Qualified epistemic delay). *Delay is epistemically supportable when the decision-relevant learning or option development it is expected to generate materially improves practical orientation and when the consequences of waiting remain acceptable relative to available alternatives.*

The proposition avoids treating information acquisition as automatically preferable. Inquiry competes with time, capacity, and consequence. Its practical value depends on whether it can change what should be done.

10.8.7 Provisional Decision

Because knowledge remains incomplete and situations continue to change, many decisions in application-dominant praxis should be understood as provisional. Provisionality does not imply indecision. A provisional decision can authorize real expenditure, create binding responsibilities, alter institutions, expose actors to consequence, and close some options. Its provisional character concerns the retained possibility and obligation of reconsideration under specified conditions.

Definition 10.178 (Provisional practical decision). A *provisional practical decision* is a consequential commitment whose scope, duration, assumptions, uncertainty, monitoring requirements, and revision conditions are explicitly specified so that the commitment can be reassessed as the practical field changes.

A strong provisional decision should state what is authorized, for whom, by whom,

at what scale, for what period, toward which ends, under which assumptions, and with what monitoring and reopening conditions. It should also distinguish elements that are intentionally temporary from elements that will create durable change. This distinction matters because a nominally temporary action can generate infrastructure, expectations, dependencies, legal precedent, or sunk costs that make later reversal difficult.

Provisionality can be implemented through expiration dates, staged authorization, pilot status, review gates, conditional continuation, modular deployment, bounded geographic scope, or explicit performance and harm triggers. The specific form depends on the action. The underlying principle is that uncertainty should be reflected in the architecture of commitment rather than acknowledged only in accompanying prose.

Definition 10.179 (Provisional decision record). A *provisional decision record* is a traceable account of the decision's evidential basis, practical rationale, threshold, residual uncertainties, affected positions, authorized scope, expected consequences, monitoring plan, revision triggers, responsible authority, and conditions for continuation, modification, suspension, or closure.

The record preserves provenance across time. Later actors can determine whether a decision was reasonable given what was known then, whether assumptions changed, whether warning signals were ignored, and whether revision obligations were fulfilled. This reduces the temptation to evaluate earlier decisions solely through outcomes known only retrospectively.

Proposition 10.180 (Structured provisionality). *Where materially relevant uncertainty remains, provisionality is practically meaningful when it is expressed through the scope, duration, monitoring, authority, and revision structure of the commitment rather than through a general statement that the decision may later change.*

Structured provisionality turns revisability into institutional and practical capacity. It also creates the bridge from decision to monitoring and learning that later sections of Part IV will develop in greater methodological detail.

10.8.8 Robustness

Robustness concerns the stability of practical support when plausible assumptions, models, observations, future conditions, or value interpretations vary. A decision can be highly attractive under one precise forecast and fragile under small changes. Another can perform acceptably across a wider range of plausible conditions. Under incomplete knowledge, the second type of option can deserve attention even when it is not locally optimal under a favored model.

Definition 10.181 (Practical robustness). *Practical robustness* is the degree to which a decision, action pathway, or protective arrangement remains sufficiently supportable across materially plausible variation in relevant assumptions, models, observations, implementation conditions, value interpretations, and future states.

Robustness differs from certainty. An option can be robust precisely because uncertainty remains. It also differs from invariance. The same action need not produce identical outcomes across conditions. Practical robustness concerns whether the option remains within an acceptable region of performance, harm, legitimacy, and revisability despite variation.

Different dimensions of robustness can conflict. An option can be technically robust but institutionally fragile. It can maintain aggregate performance while distributing failure onto the same vulnerable group in every scenario. It can be resilient to parameter variation while depending on a contested value assumption. Robustness analysis should therefore preserve the dimension across which stability is being claimed.

Definition 10.182 (Robustness profile). *A robustness profile is an account of the range of materially plausible epistemic, institutional, relational, temporal, and normative conditions across which a practical commitment remains acceptable, together with the conditions under which its support deteriorates or fails.*

Robustness can be increased through diversification, redundancy, modularity, contingency planning, staged commitment, adaptive pathways, fallback options, distributed capability, and preserved exit. Each strategy has costs. Redundancy consumes resources; modularity can reduce integration; diversification can increase coordination burden; fallback systems can become obsolete. Robustness should therefore be treated as a practical property to be designed and evaluated rather than an unconditional maximand.

Proposition 10.183 (Robust support under incomplete knowledge). *Where several materially plausible representations of the practical situation remain unresolved, a decision gains practical support when its acceptability depends less heavily on assumptions whose failure would produce serious and difficult-to-repair consequences.*

The proposition links robustness to epistemic humility. It does not eliminate the need to choose among models or interpretations. It reduces dependence on unjustified precision where the practical cost of such dependence would be high.

10.8.9 Revisability

Revisability completes the architecture of decision under incomplete knowledge. A decision made under uncertainty enters a field that will generate new manifestations, evidence, reactions, capabilities, and consequences. Revisability concerns whether the practical system can recognize these changes and alter its commitments accordingly. It is therefore both an epistemic and institutional capacity.

The term *generate* should be read strongly here. An epistemic event need not merely add information to a fixed decision state. Observation, interpretation, recognition, classification, or communication can become performatively coupled to the relational field and thereby change later capacities, action spaces, transition structures, and the relative accessibility of alternative histories. In formal models, this coupling may be represented through a generative operator, an operator-valued field, a transition kernel, a history-weight update, or another model-specific structure. A threshold-crossing rule is therefore one possible decision architecture rather than the general form of decision under incomplete knowledge.

Definition 10.184 (Decision revisability). *Decision revisability is the practical capacity to reconsider, modify, suspend, redirect, scale, or withdraw a prior commitment in response to materially relevant changes in knowledge, consequences, values, affected positions, capabilities, institutional conditions, or the action space.*

Decision revisability should be distinguished from action reversibility. A decision can remain open to revision even when some consequences of the action cannot be

undone. An institution can stop an intervention after irreversible harm has already occurred. It can change policy after a habitat has been lost, a relationship damaged, or a dependency created. Revisability is therefore necessary under incomplete knowledge but cannot substitute for caution where actions are materially irreversible. Section 274 will develop that distinction further.

Revision requires detection. Monitoring must be capable of observing the manifestations that matter. It requires authority. Someone must possess the legitimate capacity to reopen or change the decision. It requires memory. The original assumptions, evidence, and reasons must remain accessible. It requires procedural pathways. A concern must be able to reach the actors capable of responding. It also requires practical slack. If all resources, institutions, and expectations have been locked into one pathway, formal authority to revise can have little effective meaning.

Definition 10.185 (Decision revision trigger). A *decision revision trigger* is a pre-specified or subsequently recognized change in evidence, consequence, value, affected position, capability, institutional condition, or practical possibility that is sufficient to require reconsideration of an existing commitment.

Triggers can be quantitative or qualitative. A monitored indicator can cross a threshold. A previously excluded affected group can become visible. A new causal mechanism can be identified. An alternative can become available. An implementation capacity can fail. A side effect can emerge. A value conflict can intensify. A legal or institutional condition can change. The relevant trigger is any change that materially alters the practical warrant on which the decision rests.

Revisability is vulnerable to path dependence. Organizations can defend prior commitments because of sunk cost, identity, reputational investment, legal entrenchment, bureaucratic incentives, contractual lock-in, or fear of admitting error. A technically revisable decision can therefore become practically sticky. Designing revisability requires attention to these relations before commitment deepens them.

Definition 10.186 (Revision capacity). *Revision capacity* is the distributed set of epistemic, institutional, material, relational, and procedural resources that enables a practical system to detect decision-relevant change and translate that recognition into an effective alteration of prior commitment.

Proposition 10.187 (Revisability as a condition of warranted provisionality). *When a decision is justified partly by its provisional character, the practical warrant for that decision depends on the existence of credible revision capacity proportionate to the consequences and uncertainties that remain.*

Proposition 10.187 prevents provisionality from becoming rhetorical. An organization cannot rely on future correction if it lacks the means, authority, monitoring, or institutional willingness to revise.

The present section has developed decision under incomplete knowledge as a disciplined relation among epistemic sufficiency, residual uncertainty, thresholds, precaution, urgency, delay, provisional commitment, robustness, and revisability. Its central claim is that incomplete knowledge changes the architecture of decision rather than suspending the possibility of warranted action. Knowledge can be sufficient without being complete; uncertainty can remain visible without preventing commitment; thresholds can respond to consequence; precaution can be designed into the form of action; urgency and delay can be temporally decomposed; decisions can be genuinely consequential while remaining provisional; robustness can reduce dependence on

fragile assumptions; and revision capacity can keep later evidence practically effective. Section 273 now turns from the warrant for commitment to the forms that commitment can take, including action, non-action, waiting, delay, refusal, withdrawal, exit, and the generative consequences of inaction itself.

10.9 Action and Non-Action

Section 10.8 developed the conditions under which a provisional decision can become practically supportable while knowledge remains incomplete. The present section examines the forms through which such a decision can enter, remain outside, or alter an ongoing relational field. Its role is to distinguish action, non-action, waiting, delay, refusal, withdrawal, and exit as practically different modes of response rather than compressing them into a binary distinction between intervention and passivity. The objective is to clarify how each mode changes relations, capacities, temporal horizons, burdens, and future possibilities, and to make visible the opportunity costs and generative consequences that arise when a course of action is pursued, deferred, withheld, discontinued, or left unrealized. The discussion is conceptual and relational. Practical response is treated as historically situated participation in a changing field whose consequences can arise through commission, omission, temporal positioning, selective participation, and alteration of the possibilities available to others.

The distinction between action and non-action becomes difficult when a practical situation is dynamic. A decision-maker who declines a proposed intervention still occupies a position within relations that continue to develop. Existing institutions continue to allocate authority and resources. Material processes continue to unfold. Other actors adapt. Capacities can accumulate or erode. Opportunities can appear or close. A choice to wait can create information while also transferring the cost of waiting onto affected positions. A refusal can protect an actor from participation while changing the feasibility of collective action. Withdrawal can terminate one commitment while leaving dependencies created by that commitment in place. Exit can reduce direct exposure while redistributing burdens to those who remain. Practical analysis therefore requires a vocabulary that follows the relational effects of different response forms through time.

Definition 10.188 (Practical response form). A *practical response form* is a situated mode through which an actor, organization, or coordinated set of actors alters, preserves, defers, withholds, reduces, or terminates participation in a practical relation, action pathway, or institutional configuration.

Definition 10.188 places action and non-action within a common analytical field. The relevant unit is the practical relation between an actor and an evolving situation. Some response forms introduce new operations into that relation. Others withhold participation, preserve an existing configuration, postpone commitment, or alter the actor's position relative to the configuration. Their consequences depend on timing, authority, affected positions, available alternatives, and the generative dynamics of the field.

Table 10.9 summarizes the main response forms developed in this section. The entries overlap in practice. Waiting can contain preparatory action. Delay can result from institutional incapacity rather than deliberate choice. Refusal can lead to withdrawal or exit. Exit can itself require substantial action. The analytical value of the

Table 10.9: Practical response forms and their characteristic relational effects.

Response form	Primary practical operation	Characteristic relational question	Characteristic consequence concern
Action	Introduces or sustains an intervention in the field	Which relations, capacities, conditions, or pathways are changed through participation?	Direct and indirect effects, adaptation, dependency, path formation, and future option change
Non-action	Withholds a contemplated intervention or commitment	What continues, changes, or becomes possible when the contemplated intervention is absent?	Persistence, drift, accumulation, omission effects, and distributed exposure
Waiting	Maintains a temporally bounded open position	What can be learned, prepared, coordinated, or preserved during the waiting interval?	Cost of waiting, option preservation, unequal burden, and horizon change
Delay	Shifts an otherwise feasible response to a later time	What produces the temporal displacement and how does timing alter practical consequences?	Escalation, lost windows, improved readiness, and redistributed timing costs
Refusal	Withholds consent, compliance, participation, or contribution	Which relation is declined and what practical standing supports the refusal?	Protection, contestation, blocked coordination, burden transfer, and institutional response
Withdrawal	Reduces or terminates participation after prior involvement	Which prior commitments, dependencies, and responsibilities remain after participation recedes?	Transition costs, stranded obligations, capability gaps, and residual effects
Exit	Leaves or terminates membership in a practical arrangement	Who can leave, on what terms, and what happens to those who remain?	Exposure reduction, burden redistribution, lock-in, and loss of voice or capacity
Opportunity cost	Records foregone reachable alternatives	Which practical possibilities become unavailable because resources, attention, time, or commitment are allocated elsewhere?	Lost learning, deferred capability, foreclosed pathways, and displaced benefits
Inaction consequences	Tracks change generated without the contemplated intervention	Which relations and trajectories develop through continuity, omission, or field dynamics?	Entrenchment, adaptation, erosion, autonomous recovery, and future action-space change

distinctions lies in identifying the principal practical operation and its characteristic consequence structure rather than assigning each event to a single permanent category.

10.9.1 Action as Relational Intervention

Action becomes analytically significant in Generative Relational Theory when it is understood as intervention in an already structured field. An actor rarely acts on an empty background. The intervention enters relations, institutions, material arrangements, interpretations, expectations, histories, and capability distributions that condition both what can be attempted and what the attempt can generate. The same nominal action can therefore produce different consequences across situations because the receiving relational configuration differs.

Definition 10.189 (Relational intervention). A *relational intervention* is a practically organized operation that changes, sustains, activates, suppresses, redirects, or recombines one or more relations, conditions, capabilities, institutions, material arrangements, or action pathways within a practical situation.

The definition includes interventions whose immediate purpose is preservation. Maintaining a protective institution, continuing a care relation, renewing an agreement, or sustaining an infrastructure can require active intervention even when the desired outcome is continuity. Action therefore cannot be identified solely with visible novelty. Some forms of action preserve a valued relation against forces that would otherwise transform or erode it.

The relational view also broadens the consequence field. An intervention has a target, yet its effects can propagate through relations that are not themselves the declared target. A training programme can change capability, status, network access, expectations, and later bargaining relations. A technical system can reorganize workflows and authority. A legal or administrative intervention can alter classification, visibility, and access. A physical intervention can change material conditions together with the social coordination built around them. These examples differ substantively, while sharing the property that action enters a field and participates in its later organization.

Definition 10.190 (Intervention footprint). An *intervention footprint* is the provisional set of direct, mediated, distributed, and temporally extended relations through which a practical action can materially affect actors, conditions, capabilities, institutions, interpretations, or future possibilities.

An intervention footprint is a research and governance object rather than a claim of complete causal knowledge. It identifies the relations that merit practical attention given present evidence and stakes. The footprint can expand when new affected positions become visible or contract when an initially suspected pathway lacks support. Its value lies in discouraging a narrow identification of consequence with the action's immediate target.

Action also possesses a temporal structure. A discrete decision can inaugurate a pathway that persists through maintenance requirements, expectations, sunk investments, institutional commitments, and learning effects. Conversely, a long programme can consist of many revisable episodes rather than one indivisible commitment. The unit of action should therefore be chosen relative to the practical question being studied.

Definition 10.191 (Action pathway). An *action pathway* is a temporally ordered sequence of interventions, responses, adaptations, reviews, and possible revisions through which a practical commitment develops within a changing relational field.

The pathway concept connects action to the revisability developed in Section 10.8.

A provisional decision becomes practically meaningful when its pathway contains monitoring, authority, and feasible points of reconsideration. The same concept also clarifies cumulative consequences. A series of individually modest actions can generate substantial lock-in, dependence, legitimacy, or capability change through accumulation.

Action is therefore both event and participation in a trajectory. Its practical evaluation concerns more than whether the immediate operation succeeds. It also concerns the relations through which success is produced, the burdens required to sustain it, the capabilities it leaves behind, and the future action space it helps create or foreclose.

Proposition 10.192 (Relational consequence of action). *The practical consequence of an intervention includes materially relevant changes to the relational field through which later action, interpretation, capability, and consequence become possible, in addition to the intervention's immediate target effect.*

Proposition 10.192 supplies the baseline against which the remaining response forms can be understood. Non-action, waiting, refusal, withdrawal, and exit differ in operation, yet each can also alter the later relational field.

10.9.2 Non-Action as Practical Choice

Non-action requires careful treatment because several distinct conditions can appear externally similar. An actor can deliberately withhold a contemplated intervention. An actor can lack the capacity to act. An institution can prevent action. A problem can remain unrecognized. Responsibility can be fragmented so that no actor reaches commitment. A decision can be deferred through procedure without anyone explicitly selecting inaction. These conditions can all result in the absence of a contemplated intervention, while differing substantially in agency, justification, and responsibility.

Definition 10.193 (Practical non-action). *Practical non-action* is the situated absence or withholding of a contemplated intervention during a consequential interval in which the practical field continues to develop.

The definition is intentionally descriptive. It does not presume that the absence is voluntary, justified, negligent, protective, or avoidable. Those judgments require additional information about agency, capacity, authority, knowledge, alternatives, and consequence.

A first distinction therefore concerns deliberate forbearance and constrained non-action. Deliberate forbearance occurs when an actor with sufficient practical capacity and authority chooses to withhold an intervention. Constrained non-action occurs when relevant action is unavailable, blocked, unaffordable, unauthorized, unrecognized, or otherwise outside the actor's effective action space. The distinction matters because the same outward absence can carry different responsibility structures.

Definition 10.194 (Forbearance). *Forbearance* is a deliberate and practically feasible withholding of intervention, undertaken because restraint is judged preferable to one or more presently available actions.

Forbearance can be highly active in its conditions. It may require resisting pressure to intervene, preserving resources, maintaining observation, communicating restraint, protecting boundaries, or sustaining readiness. A decision to avoid unnecessary escalation can involve extensive coordination even though the focal intervention

is withheld. The practical form is defined by what is withheld relative to the decision problem, not by the total absence of activity.

Non-action also interacts with the existing baseline. A practical situation rarely remains fixed while an intervention is withheld. Institutional routines continue. Ecological and material processes continue. Relationships strengthen or decay. Markets, organizations, communities, or technical systems adapt. A baseline can therefore be dynamic, and preserving the current intervention level can still permit substantial transformation.

Definition 10.195 (Dynamic non-action baseline). *A dynamic non-action baseline is a representation of the materially relevant processes expected to continue, accumulate, adapt, recover, or deteriorate during the absence of a contemplated intervention.*

The dynamic baseline guards against a common practical simplification in which action is associated with change and non-action with stasis. Sometimes non-action permits recovery. Sometimes it permits harm to compound. Sometimes it allows actors to self-organize. Sometimes it entrenches an incumbent relation. The baseline must therefore be reconstructed rather than assumed.

Agency also affects whether non-action can be described as choice. Where an actor lacks relevant capability, information, authority, or practical access, the absence of intervention is better analyzed first as a feature of the action space. Where an actor could act yet delegates, ignores, or withholds response, the practical analysis shifts toward judgment and responsibility. The boundary can remain uncertain where institutional agency is distributed across many positions.

Proposition 10.196 (Agency-sensitive interpretation of non-action). *The practical interpretation of non-action depends on the relation among effective capacity, authority, knowledge, feasible alternatives, and the temporal consequences of withholding intervention.*

Proposition 10.196 avoids assigning the same meaning to inaction produced by incapacity and inaction produced by deliberate restraint. It also prepares the later analysis of responsibility, where causal contribution, practical capacity, authority, and foreseeability can diverge.

10.9.3 Waiting

Waiting is a temporally structured response in which commitment remains open while the practical situation continues to evolve. Section 10.8 examined delay primarily as an epistemic resource. The present subsection treats waiting more broadly as a form of practical organization. Waiting can preserve options, allow observation, create time for participation, permit coordination, support recovery, or synchronize action with a more favorable moment. It can also impose burdens on those who remain exposed during the interval.

Definition 10.197 (Practical waiting). *Practical waiting is a temporally bounded mode of praxis in which one or more commitments remain open while actors observe, prepare, coordinate, recover, negotiate, or preserve options within an evolving practical situation.*

Practical waiting differs from simple inactivity because it contains an orientation toward a future decision, condition, or transition. The waiting period can be actively structured. Actors can gather evidence, maintain capabilities, consult affected posi-

tions, negotiate authority, prepare contingencies, build infrastructure, or define trigger conditions. The quality of waiting therefore depends partly on what the interval is used to generate.

Definition 10.198 (Waiting horizon). A *waiting horizon* is the temporal interval over which a practical commitment remains intentionally open, together with the conditions expected to justify continuation, termination, acceleration, or conversion of waiting into another response form.

A waiting horizon prevents open-ended postponement from being disguised as temporary restraint. It can be defined by clock time, event occurrence, threshold crossing, completion of inquiry, institutional readiness, seasonal conditions, or changes in risk. The horizon can itself be revised when the practical situation changes, provided that the reason for revision remains explicit.

Waiting is often distributed asymmetrically. One actor may experience waiting as preserved flexibility while another experiences the same interval as continued exposure, uncertainty, deprivation, or inability to plan. An organization can defer a decision at low institutional cost while individuals bear accumulating consequences. A powerful actor can afford strategic patience that a vulnerable actor cannot. The practical evaluation of waiting therefore requires a burden profile.

Definition 10.199 (Waiting burden profile). A *waiting burden profile* is an account of how the costs, risks, uncertainties, opportunities, and capability effects of a waiting interval are distributed across materially affected positions.

The burden profile can reveal why the same amount of time has different practical meaning across positions. It also connects waiting to justice and participation. Actors bearing the greatest cost of delay can have strong reasons to contest a decision-making timetable established by actors whose exposure is lower.

Waiting can be valuable because it preserves reversibility and permits learning. It can also reduce future capacity by allowing expertise to disperse, infrastructure to decay, trust to erode, or political windows to close. Evaluation should therefore compare what the interval is expected to generate with what it is expected to consume or expose.

Proposition 10.200 (Productive waiting). *Waiting gains practical support when the interval preserves or generates decision-relevant capability, knowledge, coordination, legitimacy, or optionality at a burden proportionate to the consequences of acting earlier.*

The proposition treats waiting as a designed practical interval. It provides no presumption that slower action is intrinsically more prudent. In some situations, the burden of waiting dominates its informational or coordinative value.

10.9.4 Delay

Delay concerns temporal displacement relative to an earlier feasible or expected response. It overlaps with waiting while carrying a different analytical emphasis. Waiting describes a mode of organized openness. Delay identifies the relation between a response and a prior temporal possibility. An actor can wait without a meaningful earlier opportunity to act; a response can also be delayed through congestion, institutional procedure, conflict, incapacity, strategic obstruction, or coordination failure without anyone having designed a waiting period.

Definition 10.201 (Practical delay). A *practical delay* is the displacement of a materially relevant action, decision, review, or transition from an earlier feasible or expected time to a later time within a changing practical situation.

The definition makes the reference point explicit. Calling something delayed presupposes a relation to an earlier feasible or normatively relevant time. That reference point can be contested. Actors may disagree about when evidence became sufficient, when authority existed, when consequences became foreseeable, or when coordination became practically possible. Delay analysis should therefore state the temporal benchmark rather than treating lateness as self-evident.

Delay can arise from several mechanisms. Epistemic delay seeks additional knowledge. Procedural delay follows required review, consultation, or authorization. Capability delay reflects missing resources, expertise, infrastructure, or coordination. Conflict-generated delay arises when actors contest the problem, end, authority, or action. Strategic delay occurs when an actor benefits from postponement. Systemic delay can emerge from distributed processes in which no single actor controls the overall timetable.

Definition 10.202 (Delay mechanism). A *delay mechanism* is the relational process through which a practically relevant response is displaced from an earlier feasible or expected time.

Identifying the mechanism matters because different delays require different responses. More evidence can address epistemic delay while doing little about absent authority. Streamlined procedure can reduce administrative delay while undermining participation if procedural time performs a legitimacy function. Additional funding can improve capability while leaving strategic obstruction untouched. A generic demand for speed can therefore misdiagnose the relation producing delay.

The consequences of delay are also path-dependent. A short delay near a threshold can matter more than a long delay during a stable period. Postponement can allow a harmful process to compound or permit a temporary disturbance to resolve without intervention. It can preserve options or allow them to disappear. It can reduce implementation error or increase transition cost. Practical evaluation requires attention to the trajectory that develops during the displacement.

Definition 10.203 (Delay consequence profile). A *delay consequence profile* is an account of the materially relevant changes in exposure, capability, uncertainty, legitimacy, option availability, and future intervention conditions generated during a period of practical delay.

Delay therefore has both cause and consequence. The mechanism explains why the response moved in time; the consequence profile explains what the displacement generated. Keeping these analytically separate allows a delay to be understandable in origin while costly in effect, or institutionally burdensome in origin while beneficial in consequence.

10.9.5 Refusal

Refusal is a response form in which an actor explicitly or effectively withholds consent, compliance, participation, endorsement, information, labor, resources, or another contribution expected by a practical arrangement. It differs from general non-action because the withheld relation is more determinate. Refusal responds to an

invitation, demand, requirement, norm, institutional role, or proposed course of action and thereby alters the relational conditions under which collective praxis can proceed.

Definition 10.204 (Practical refusal). A *practical refusal* is the withholding of a specified form of consent, compliance, participation, endorsement, or contribution from a practical relation or proposed course of action.

Refusal can perform several functions. It can protect an actor from unacceptable exposure. It can contest the legitimacy of an end or procedure. It can signal that a burden distribution is rejected. It can prevent an institution from treating silence as consent. It can also obstruct coordination needed to address a shared problem. The practical meaning therefore depends on the relation refused, the standing of the refusing actor, the consequences for affected positions, and the alternatives available.

The possibility of refusal is itself unevenly distributed. Some actors can refuse without losing livelihood, status, safety, care, residence, access, or future opportunity. Others face substantial penalties for declining participation. Formal permission to refuse can therefore coexist with severe practical coercion. Analysis should distinguish the nominal right of refusal from the effective capacity to exercise it.

Definition 10.205 (Effective refusal capacity). *Effective refusal capacity* is the practical ability to withhold a specified form of participation or consent without facing consequences so severe that the nominal option becomes materially inaccessible.

Effective refusal capacity connects this subsection to the unequal action spaces developed in Section 10.7. It also prepares later analysis of power. The actor able to impose terms can sometimes present acceptance as voluntary even where refusal is practically unavailable.

Refusal can reshape collective action. One actor's refusal may protect a legitimate boundary while increasing the burdens borne by others. A refusal can induce renegotiation, redesign, substitution, or institutional learning. It can also trigger exclusion, retaliation, or replacement. The consequence field therefore extends beyond the refusing actor.

Definition 10.206 (Refusal consequence profile). A *refusal consequence profile* is an account of how withholding participation changes the positions, burdens, capacities, legitimacy, and available pathways of the refusing actor and other materially affected participants.

A refusal can therefore be both self-regarding and field-transforming. Its evaluation requires attention to the practical standing for refusal together with the consequences generated through the relation from which participation is withheld.

10.9.6 Withdrawal

Withdrawal occurs after participation has begun. An actor reduces, suspends, or terminates involvement in an ongoing relation, programme, institution, commitment, or action pathway. This temporal position distinguishes withdrawal from refusal at entry. Prior participation can create expectations, dependencies, responsibilities, sunk investments, knowledge asymmetries, and capabilities whose effects persist after involvement recedes.

Definition 10.207 (Practical withdrawal). A *practical withdrawal* is the partial or complete reduction of an actor's ongoing participation in an established practical re-

lation, commitment, institution, or action pathway.

Withdrawal can be planned from the beginning. Temporary missions, pilot programmes, emergency measures, rotating responsibilities, and time-limited collaborations can include explicit withdrawal conditions. Such design can preserve autonomy and prevent indefinite dependency. Withdrawal can also be reactive, following failure, changed evidence, unacceptable consequences, exhausted capability, loss of legitimacy, or changed priorities.

The practical quality of withdrawal depends on transition. Sudden termination can create capability gaps, stranded users, abandoned infrastructure, unresolved obligations, or abrupt redistribution of risk. Gradual withdrawal can allow handover, local capability development, alternative provision, documentation, repair, and renegotiation. Gradualism itself can impose continuing costs where the underlying relation has become harmful. Transition design must therefore remain consequence-sensitive.

Definition 10.208 (Withdrawal transition). A *withdrawal transition* is the organized process through which participation is reduced or terminated while residual responsibilities, dependencies, capabilities, material arrangements, and affected positions are identified and addressed.

Residual effects are especially important. Ending an intervention does not necessarily return the practical field to its prior state. Expectations may have changed. Local alternatives may have disappeared. Institutions may have reorganized around the intervention. Skills and dependencies may have developed. Trust can have been gained or lost. Material infrastructure can remain. Withdrawal should therefore be evaluated relative to the transformed field produced through prior participation.

Definition 10.209 (Residual commitment profile). A *residual commitment profile* is an account of the obligations, dependencies, repair requirements, knowledge-transfer needs, and continuing consequences that remain materially relevant after participation is reduced or terminated.

The profile does not imply indefinite obligation. Its purpose is to make transition consequences explicit. Some responsibilities can reasonably terminate with the relation; others can persist because prior action generated dependencies or harms that remain practically attributable to the withdrawing actor or institution.

Proposition 10.210 (Withdrawal from a transformed field). *Withdrawal should be evaluated in relation to the field produced through prior participation, including dependencies, capabilities, expectations, and risks that did not exist in the same form before the commitment began.*

Withdrawal analysis should therefore avoid treating the pre-intervention situation as an automatically recoverable baseline (Proposition 10.210). The same result connects withdrawal to irreversibility, which Section 274 develops in greater detail.

10.9.7 Exit

Exit is a more encompassing change of position in which an actor leaves, terminates membership in, or materially separates from a practical arrangement. Withdrawal can reduce participation while a relation remains. Exit changes the actor's membership, exposure, or attachment to the arrangement itself. The distinction is contextual: leaving a programme can be withdrawal from one perspective and exit from the programme from another. The analytical question concerns the degree to which

the actor's relational position is terminated or relocated.

Definition 10.211 (Practical exit). A *practical exit* is the termination or substantial relocation of an actor's membership, attachment, or exposure within a practical arrangement such that the actor ceases to occupy a previously operative position in that arrangement.

Exit can protect actors from continuing harm, coercion, exploitation, or unacceptable dependency. It can also remove expertise, resources, participation, solidarity, or voice from a collective arrangement. Where exit is easy for powerful actors and difficult for vulnerable actors, the availability of exit can intensify asymmetry. Those able to leave can avoid the costs of deterioration while those with fewer alternatives remain exposed.

Definition 10.212 (Exit capacity). *Exit capacity* is the practical ability to leave or substantially relocate from a relation or institutional arrangement, considering material resources, legal and institutional permission, social dependence, information, timing, alternative positions, and the consequences of departure.

Exit capacity therefore belongs to the effective action space. A formal ability to resign, relocate, switch provider, leave a platform, terminate a contract, or cease participation can carry little practical meaning where viable alternatives are absent or departure costs are prohibitive.

Exit also creates a remainder. The arrangement continues for those who stay, often with altered resources, composition, legitimacy, and burden distribution. A skilled participant's exit can reduce collective capability. A major funder's exit can transfer financial pressure. The departure of highly mobile actors can weaken incentives to repair an institution that less mobile actors must continue to inhabit. Conversely, credible exit can discipline institutions by making persistent mistreatment costly.

Definition 10.213 (Exit remainder). An *exit remainder* is the set of materially relevant changes in burden, capability, legitimacy, resource distribution, and future possibility experienced by the practical arrangement and the actors who remain after an exit occurs.

The remainder makes exit relational. Its consequences cannot be assessed solely through the welfare or freedom of the departing actor. Practical evaluation also concerns what departure generates for the remaining field, especially where prior participation created dependencies or where exit opportunities are unequally distributed.

Exit can also interact with voice, reform, and repair. Leaving an arrangement can preserve personal agency while reducing the departing actor's future capacity to influence that arrangement. Remaining can preserve voice while maintaining exposure. The practical choice depends on stakes, alternatives, power, responsibility, and the possibility of collective transformation. Chapter 10 later returns to these relations through power, participation, and responsibility.

10.9.8 Opportunity Cost

Every practical commitment allocates scarce elements of the action space. Time, attention, organizational capacity, authority, material resources, political capital, trust, learning capacity, and opportunities for coordination can be directed toward one pathway while becoming less available for others. Opportunity cost provides a general language for these foregone possibilities. Within the present chapter, the concept

is used beyond monetary calculation. Its function is to make displaced practical possibilities visible.

Definition 10.214 (Practical opportunity cost). A *practical opportunity cost* is the value, capability, learning, protection, relation, or future possibility foregone because a scarce practical resource, temporal window, commitment, or institutional capacity is allocated to one pathway rather than another reachable alternative.

The concept depends on reachability. A hypothetical alternative outside the actor's effective action space should not automatically be treated as a meaningful opportunity cost. Section 10.7 distinguished nominal possibility from effective reachability; the same discipline applies here. Opportunity-cost analysis should compare practical alternatives that were materially available, plausibly activatable, or could have become available through a specified activation pathway.

Opportunity cost can be distributed. An institution can gain from concentrating resources on one objective while another population bears the consequence of an unattended problem. A government, firm, community, laboratory, household, or international organization can direct scarce attention toward one domain while reducing readiness elsewhere. The foregone value can therefore accrue to actors different from those who chose the allocation.

Definition 10.215 (Distributed opportunity-cost profile). A *distributed opportunity-cost profile* is an account of which materially affected positions bear the foregone benefits, capabilities, protections, learning, or future options associated with a practical commitment.

Opportunity cost can also be generative. Choosing one pathway can build specialized infrastructure, expertise, standards, identities, and expectations that make continuation easier while making alternatives increasingly expensive. The initial opportunity cost can therefore evolve into path dependence. Conversely, an action that builds general-purpose capability can reduce future opportunity costs by making several later pathways more reachable.

The temporal horizon matters. A pathway with high immediate opportunity cost can create capabilities that expand later action space. A low-cost immediate choice can consume a rare window and impose a large future cost. Practical comparison should therefore distinguish short-horizon displacement from long-horizon generative effects.

Definition 10.216 (Opportunity-cost horizon). An *opportunity-cost horizon* is the temporal range over which foregone practical possibilities and the capability effects of a commitment are assessed.

The concept also applies to non-action. Resources held in reserve, attention withheld, decisions deferred, and capacities left unused can preserve future flexibility while foregoing present benefits or protections. Opportunity cost therefore belongs to the analysis of action and non-action alike.

Proposition 10.217 (Opportunity cost as action-space transformation). *Where a practical commitment changes which alternatives remain reachable, its opportunity cost includes the transformation of the later action space in addition to the immediate value of foregone alternatives.*

Proposition 10.217 connects opportunity cost to the broader Generative Relational concern with future possibility. The cost of choosing a pathway can include options that disappear because the choice changes capabilities, institutions, expectations, or

material conditions.

10.9.9 Generative Consequences of Inaction

The final subsection brings the preceding response forms into a generative analysis of inaction. The absence of a contemplated intervention does not create a causal vacuum. Existing relations continue to generate manifestations and constraints. Other actors respond to the absence. Institutions reproduce routines. Material systems develop. Knowledge changes. Capabilities accumulate or erode. The practical field can therefore move along a trajectory partly constituted by what is left undone.

Definition 10.218 (Generative consequence of inaction). A *generative consequence of inaction* is a materially relevant change in relations, capabilities, institutions, conditions, exposures, interpretations, or future action possibilities that develops during the absence or withholding of a contemplated intervention and is practically attributable, in part, to that response configuration.

The qualification “in part” is important. The field contains processes that would develop independently of the actor’s choice. Attribution therefore requires a counterfactual comparison between plausible trajectories under the contemplated intervention and under its absence, together with attention to uncertainty and interacting causes. The concept should not turn every later event into a consequence of whoever failed to intervene.

Several patterns are especially relevant. Inaction can permit an incumbent relation to become entrenched. A temporary disparity can become institutionalized. Infrastructure can deteriorate. Skills can atrophy. Trust can erode. Harm can accumulate. A window for low-cost intervention can close. These are generative effects because the later field differs in its capacities, dependencies, and possibilities.

Inaction can also permit beneficial processes. An overmanaged system can recover through restraint. Local actors can develop capabilities when external intervention is withheld. Uncertainty can resolve. A transient disturbance can dissipate. Premature standardization can be avoided. Actors can retain autonomy that an intervention would have narrowed. Generative analysis therefore evaluates the trajectory rather than assuming that intervention is intrinsically superior to restraint.

Definition 10.219 (Inaction trajectory). An *inaction trajectory* is a provisional reconstruction of the relational, material, institutional, epistemic, and capability changes expected or observed during a consequential interval without the contemplated intervention.

The trajectory can include waiting, deliberate forbearance, incapacity, institutional omission, fragmented responsibility, or strategic delay. These mechanisms should remain distinguishable because they carry different implications for responsibility and future design.

A further issue concerns invisibility. Consequences of action are often easier to associate with a discrete intervention because the intervention supplies a visible event. Consequences of inaction can emerge gradually and be attributed to background conditions, especially where responsibility is distributed. Practical records should therefore preserve the decision context, the alternatives considered, the capacities available, and the reasons for withholding intervention when those facts are materially relevant.

Definition 10.220 (Inaction consequence record). An *inaction consequence record* is a traceable account of the contemplated intervention, the reasons and conditions associated with its absence, the relevant capacities and alternatives, the expected baseline, the affected positions, and the consequences that later became visible during the interval of non-intervention.

Such a record supports learning without presuming blame. It allows later inquiry to compare expectations with actual trajectories and to revise models of both intervention and restraint. It can reveal, for example, that a feared deterioration did not occur, that a self-organizing capacity was underestimated, or that a supposedly stable baseline contained accumulating harm.

The distribution of inaction consequences is especially important. The actor deciding to withhold intervention can be relatively insulated from the resulting exposure. Those bearing the consequences may have little influence over the decision. Conversely, an intervention demanded by distant decision-makers can impose greater risk on local actors than continued restraint. The practical comparison must therefore follow positions as well as aggregate outcomes.

Proposition 10.221 (Relational symmetry of practical consequence). *For purposes of practical evaluation, materially consequential changes generated through intervention and materially consequential changes generated during its withholding both belong to the consequence structure of the decision problem, subject to the same requirements of evidence, attribution, distributional analysis, and uncertainty disclosure.*

The proposition establishes an analytical symmetry rather than a causal equivalence. Action and inaction operate through different mechanisms and can carry different responsibility structures. The point is that withholding intervention cannot serve as an automatic zero-consequence baseline.

Definition 10.222 (Response-form consequence profile). A *response-form consequence profile* is a comparative account of the expected or observed direct, relational, temporal, distributional, and generative consequences associated with feasible forms of action, waiting, delay, refusal, withdrawal, exit, and non-action within a practical situation.

The profile integrates the section. It encourages comparison across response forms without forcing them onto a single metric. A refusal can protect autonomy while reducing collective capacity. Waiting can improve knowledge while extending exposure. Exit can protect one actor while weakening those who remain. Intervention can solve an immediate problem while narrowing future options. Non-action can preserve optionality while allowing harm to accumulate. Practical judgment must retain these heterogeneous consequences rather than compressing them into a binary choice between doing something and doing nothing.

The present section has developed action and non-action as a family of relational response forms. Action intervenes in an already structured field and leaves an intervention footprint. Non-action occurs within a dynamic baseline and requires agency-sensitive interpretation. Waiting organizes an open temporal interval; delay identifies displacement relative to an earlier feasible or expected response. Refusal withholds a specified relation of participation, withdrawal changes an established commitment, and exit relocates or terminates membership in an arrangement. Opportunity cost records the reachable possibilities displaced by commitment, while generative analysis follows the trajectories that develop when intervention is withheld. Across these forms, practical consequence includes changes in relations, capacities, burdens,

timing, and future action spaces. Section 274 develops the next dimension of this architecture by examining risk and irreversibility: the possibility that action or non-action generates losses, exposures, and foreclosures whose probability, distribution, and recoverability vary across practical positions and temporal horizons.

10.10 Risk and Irreversibility

Section 10.9 treated action and non-action as relational response forms whose consequences develop within an already changing field. The present section examines a further dimension of practical commitment: the possibility that action, restraint, delay, withdrawal, or continued participation exposes differently situated actors and systems to losses whose likelihood, pathway, magnitude, distribution, or recoverability remains partly uncertain. Its role is to develop a domain-general Generative Relational account of risk and irreversibility that can later support the analysis of power, responsibility, justice, and concrete intervention methodology. The objective is to distinguish known risk, uncertain risk, relational risk, systemic risk, risk distribution, tail risk, and different degrees of reversibility, and then to connect them to the preservation and foreclosure of future options. The discussion is conceptual and relational. Risk is treated as a property of situated consequence structures rather than as a single scalar attached to an isolated choice, while irreversibility is treated as a matter of practical recoverability across relevant relations, positions, and temporal horizons.

Application-dominant praxis frequently proceeds under conditions in which some adverse consequences are well characterized, others remain poorly specified, and still others can emerge through interactions that become visible only after intervention. Risk therefore cannot be reduced to a known probability multiplied by a known loss. Such a representation can be useful in restricted settings, but the broader practical field can include uncertain causal pathways, unequal exposure, cascading effects, delayed manifestations, institutional fragility, capability loss, and the foreclosure of later alternatives. These features are especially important where action changes the structure through which future consequences are generated.

Definition 10.223 (Practical risk). *Practical risk* is a situated relation among one or more possible adverse consequences, the actors or systems exposed to them, the mechanisms or pathways through which they may arise, the uncertainty surrounding their likelihood or magnitude, and the practical capacity to prevent, absorb, repair, or revise what follows.

This definition gives risk both an epistemic and a relational structure. The same physical event can represent very different practical risks for actors with different exposure, reserves, legal protection, mobility, voice, or recovery capacity. Likewise, the same estimated probability can carry different practical meaning when consequences differ in reversibility, distribution, duration, or future option loss. Risk analysis should therefore preserve the relations through which exposure and recovery are produced.

Table 10.10 organizes the section around two connected questions. The first concerns exposure: what adverse consequences can arise, how well are they understood, through which relations can they propagate, and who bears them? The second concerns recoverability: if an adverse consequence occurs or a commitment later proves poorly oriented, which aspects of the prior practical field can be restored, which can

Table 10.10: Analytical dimensions of risk and irreversibility in application-dominant praxis.

Dimension	Primary object	Characteristic practical concern	Typical analytical response
Known risk	Characterized adverse consequence and exposure	Comparison among materially understood consequence pathways	Estimation, mitigation, allocation, insurance, reserve, or monitoring
Uncertain risk	Partly unknown likelihood, magnitude, or mechanism	False precision and omitted pathways	Scenario variation, sensitivity, staged exposure, learning, and uncertainty retention
Relational risk	Dependence, asymmetry, interaction, and position	Risk generated through relations rather than isolated actors	Mapping dependencies, transmission paths, bargaining positions, and recovery capacities
Systemic risk	Interconnected structures and propagation	Cascades, common-mode failure, feedback, and threshold effects	Network and system mapping, containment, redundancy, modularity, and stress analysis
Risk distribution	Allocation of exposure and recovery capacity	Separation between decision authority, benefit, and burden	Positional analysis, participation, compensation, protection, and accountability
Tail risk	Extreme or weakly observed adverse consequence	Large loss under sparse evidence or structural uncertainty	Precaution, stress cases, reserve, exposure limits, and preservation of fallback options
Reversibility	Capacity to restore or reconstruct valued conditions	Cost, delay, incompleteness, and asymmetry of recovery	Rollback design, repair pathways, modularity, staged commitment, and review
Irreversibility	Loss of practically reachable return pathways	Lock-in, path creation, capability loss, and durable foreclosure	Higher thresholds, narrower exposure, stronger participation, and option preservation
Option preservation	Retention of meaningful future alternatives	Future agency and revisability after present commitment	Diversity, slack, interoperability, modularity, exit capacity, and delayed closure
Option foreclosure	Loss or severe degradation of later alternatives	Distribution of future constraint and dependence	Foreclosure tracing, justification, compensation, repair, and reopening where feasible

only be partly repaired, and which future possibilities have been lost? Risk and irreversibility intersect because the significance of an adverse consequence depends partly on what recovery remains possible after it occurs.

10.10.1 Known Risk

Known risk concerns adverse consequence structures that are sufficiently characterized for disciplined comparison. The relevant consequence classes are identifiable, important exposure pathways are reasonably understood, and the available evidence supports some bounded assessment of frequency, likelihood, magnitude, or range. The degree of knowledge can still be imperfect. The category indicates that the practical architecture of the risk is understood well enough for explicit estimation and

mitigation to be meaningful.

Definition 10.224 (Known practical risk). A *known practical risk* is an adverse consequence structure for which the principal consequence classes, exposed positions, and causal or transmission pathways are sufficiently characterized to support a bounded assessment of likelihood, magnitude, or frequency for the practical decision at hand.

The phrase “for the practical decision at hand” preserves the action-relative structure developed in Section 10.8. A risk can be adequately characterized for a small reversible trial while remaining insufficiently characterized for system-wide deployment. A short-horizon failure rate can be well understood while long-horizon capability effects remain uncertain. A known average exposure can coexist with poorly understood distributional extremes. Known risk therefore refers to a bounded practical object rather than complete knowledge of the future.

Several familiar tools become meaningful under these conditions. Frequency estimates can inform reserve requirements. Probabilistic ranges can support comparison among alternatives. Failure data can inform maintenance intervals. Historical variability can help specify operating envelopes. Expected-loss calculations can contribute to resource allocation. These methods are useful when their assumptions and reference classes remain explicit and when their outputs are connected to the positions actually exposed.

Known risk also supports targeted mitigation. An identifiable failure pathway can be isolated. A known exposure can be capped. Redundancy can be introduced around a recurrent failure point. Protective capacity can be placed where consequence is concentrated. Monitoring can be matched to a known precursor. The practical advantage of characterization lies in the possibility of designing response around a reasonably specified mechanism.

Definition 10.225 (Risk characterization profile). A *risk characterization profile* is a traceable account of the adverse consequence classes, exposure pathways, affected positions, available likelihood or frequency information, magnitude ranges, temporal horizons, and mitigation capacities relevant to a practical decision.

The profile should preserve uncertainty inside the known-risk category. A probability interval, a confidence bound, a range of plausible severity, or an explicitly limited reference class can be more informative than a single point estimate. The purpose is practical orientation rather than numerical closure.

Known risk can also be historically unstable. A risk characterized under one institutional arrangement, technology, ecology, or social practice can change when the surrounding relations change. A familiar probability can cease to travel well across contexts. Risk records should therefore preserve the conditions under which characterization was established.

Proposition 10.226 (Contextual dependence of characterized risk). A *risk estimate remains practically informative only to the extent that the relations, exposure pathways, reference conditions, and recovery capacities supporting the estimate remain sufficiently comparable to the situation in which the estimate is applied.*

Proposition 10.226 prevents known risk from becoming an unqualified claim of stability. Characterization is valuable because it makes disciplined action possible, while its scope remains relationally bounded.

10.10.2 Uncertain Risk

Uncertain risk arises when one or more practically important elements of the adverse consequence structure remain poorly characterized. The uncertainty can concern probability, magnitude, timing, mechanism, affected positions, interaction effects, or even the relevant consequence categories. The practical challenge is therefore different from ordinary estimation. The task is partly to act while the structure being estimated remains incomplete.

Definition 10.227 (Uncertain practical risk). An *uncertain practical risk* is an adverse consequence structure in which materially relevant likelihoods, magnitudes, mechanisms, exposure pathways, affected positions, or consequence classes remain insufficiently characterized for stable probabilistic comparison.

Uncertain risk can take several forms. A consequence can be understood while its frequency is poorly known. A failure frequency can be estimated while downstream effects remain uncertain. Mechanisms can be contested. Long-run consequences can depend on institutional adaptation that has not yet occurred. A novel intervention can generate categories of consequence that existing monitoring was not designed to observe. In these settings, numerical precision can conceal rather than reduce uncertainty.

The appropriate response is therefore often structural. Praxis can diversify assumptions, examine alternative causal pathways, stress boundary conditions, identify vulnerable positions, limit exposure, preserve rollback capacity, and stage commitment so that learning occurs before wider expansion. Qualitative evidence and historical analogy can be especially important where event counts are sparse but mechanisms or vulnerabilities are visible.

Definition 10.228 (Uncertain-risk profile). An *uncertain-risk profile* is an account of which components of an adverse consequence structure are well characterized, weakly characterized, contested, unobserved, or potentially emergent, together with the practical implications of those differences for commitment and monitoring.

This profile prevents a broad label of “uncertainty” from obscuring where uncertainty actually lies. Uncertainty about event frequency calls for a different response from uncertainty about who is exposed. Uncertainty about mechanism differs from uncertainty about normative significance. Uncertainty about recovery capacity can be especially important when a consequence is difficult to reverse.

A further issue concerns uncertainty generated by action itself. Intervention can change reporting incentives, behavior, institutions, or interaction patterns in ways that alter the future risk structure. Early estimates can become obsolete because the practical field adapts to the intervention. Risk governance therefore needs revision conditions, not merely an initial assessment.

Proposition 10.229 (Uncertain risk and commitment design). *Where materially relevant features of a risk structure remain uncertain, practical warrant can be strengthened by designing commitment so that exposure, learning, monitoring, and revisability are proportionate to the unresolved uncertainty.*

The proposition extends the precautionary architecture of Section 10.8. It does not imply that uncertain risk always requires reduced action. In some situations, inaction carries greater uncertain risk than intervention. The relevant comparison concerns the uncertain consequence structures of the feasible response forms.

10.10.3 Relational Risk

Relational risk concerns adverse consequences generated, amplified, transferred, or concentrated through relations among actors, institutions, technologies, infrastructures, and environments. The unit of analysis is therefore broader than an isolated actor or event. Dependence, asymmetry, coordination, trust, contractual structure, information flow, authority, and interconnection can all become parts of the risk-generating mechanism.

Definition 10.230 (Relational risk). *Relational risk* is risk whose likelihood, magnitude, distribution, or recoverability depends materially on the structure and evolution of relations among actors, institutions, material systems, or environments.

A relation can generate risk in several ways. Dependence on a single supplier can make disruption consequential. Information asymmetry can allow one actor to externalize exposure onto another. Centralized authority can accelerate coordinated response while also creating common-mode failure. Dense trust can support rapid cooperation while making betrayal or misinformation more consequential. A contractual arrangement can shift liability away from the actor best positioned to prevent harm. A social norm can distribute coping costs toward actors with less power to refuse them.

Relational risk also concerns the difference between risk production and risk bearing. The actor creating an exposure can be different from the actor absorbing the consequence. Decision authority can sit elsewhere again. These separations matter because mitigation incentives, knowledge, and responsibility can become misaligned.

Definition 10.231 (Risk-generation relation). A *risk-generation relation* is a relation through which an actor, institution, process, or material configuration materially alters the exposure, vulnerability, consequence magnitude, or recovery capacity of another position.

The concept does not presume wrongful conduct. A relation can generate risk even when all participants act within accepted rules. The analytical task is to identify how the configuration produces exposure and which positions have capacity to change it.

Relational risk can also be reciprocal. Two actors can create mutual dependence. Coordination failure can expose all participants. A shared infrastructure can create joint vulnerability. Reciprocal exposure, however, should not be confused with symmetric exposure. One actor can possess reserves, exit options, legal protection, or political influence that another lacks.

Definition 10.232 (Relational exposure profile). A *relational exposure profile* maps how dependence, authority, information, coordination, access, and recovery capacity distribute risk across positions connected within a practical situation.

This profile prepares the later treatment of power in Section 275. A relation can be economically, technically, or administratively efficient while also placing one actor in a position of concentrated exposure. The risk analysis should retain both features rather than allowing aggregate performance to erase positional vulnerability.

Proposition 10.233 (Relational production of vulnerability). *Where exposure and recovery capacity are materially shaped by relations of dependence, authority, information, access, or coordination, practical risk cannot be adequately assessed from actor-level probabilities alone.*

10.10.4 Systemic Risk

Systemic risk arises when adverse consequences can propagate across interconnected components and alter the operation, stability, or generative capacity of the wider system. The concern is therefore not only the failure of one component but the possibility that interdependence changes the scale and form of consequence.

Definition 10.234 (Systemic practical risk). *Systemic practical risk* is the possibility that a disturbance, failure, adaptation, or intervention propagates through interdependent relations and produces consequential change across multiple components, scales, or functions of a practical system.

Systemic risk can develop through cascading failure, common dependencies, reinforcing feedback, threshold effects, synchronization, institutional imitation, shared standards, or concentration around critical nodes. The same connectivity that supports coordination and efficiency can therefore create pathways for propagation. Generative Relational analysis treats this ambivalence as structural. Connectivity can generate capacity and vulnerability at the same time.

A system can also appear locally stable while becoming globally fragile. Individual actors can satisfy local requirements while shared dependence accumulates at system level. Conversely, local failures can be tolerated when the wider system contains redundancy, substitutability, modularity, or reserve capacity. Risk analysis therefore needs multiple scales.

Definition 10.235 (Propagation pathway). A *propagation pathway* is a relational sequence through which an initial disturbance can alter the state, capacity, exposure, or behavior of connected components and thereby transmit or transform consequence across a system.

Propagation does not need to be linear. Feedback can amplify or dampen an initial disturbance. Actors can adapt strategically. Institutions can change rules. A technical failure can become a coordination failure, which then becomes a legitimacy problem. The identity of the consequence can change as it moves through the field.

Systemic risk also has a temporal structure. Slow accumulation can create a threshold that becomes visible only when a later disturbance triggers rapid change. A temporary emergency response can create dependencies that become permanent. A protective intervention can shift risk into another subsystem or future period. Systemic analysis should therefore include both immediate propagation and longer-horizon structural transformation.

Definition 10.236 (Systemic fragility profile). A *systemic fragility profile* is an account of critical dependencies, propagation pathways, feedback relations, concentration points, redundancy, substitutability, recovery capacity, and plausible threshold conditions within a practical system.

Systemic risk can be governed through several architectures: modularity can limit propagation; redundancy can maintain function after failure; diversity can reduce common-mode exposure; reserves can absorb disturbance; interoperability can enable substitution; monitoring can identify early propagation; and decentralized capacity can prevent dependence on a single point of coordination. These design properties can also carry costs, including duplication, slower coordination, or reduced standardization. Their value is situation-dependent.

Proposition 10.237 (Systemic consequence beyond local optimization). *Where practi-*

cal consequences propagate through interdependent relations, locally attractive actions can increase system-level fragility, and locally redundant or costly capacities can contribute to system-level robustness.

This proposition reinforces the need to evaluate action beyond its immediate local objective. It also prepares the later discussion of collective and institutional praxis in Section 279.

10.10.5 Distribution of Risk

Risk is distributed through the practical field. Some actors benefit from an action while others bear its downside exposure. Some possess authority to decide while others possess limited capacity to refuse. Some can absorb a loss, repair damage, or exit the arrangement, while others face durable consequences. Aggregate risk measures can therefore conceal practically decisive positional differences.

Definition 10.238 (Risk distribution). *Risk distribution* is the allocation across practical positions of exposure to adverse consequences, uncertainty, prevention burdens, monitoring burdens, recovery costs, residual harm, and the capacities available to avoid, transfer, absorb, repair, or exit those consequences.

Distribution concerns more than expected loss. Two actors can face the same expected monetary loss while differing greatly in resilience, irreversibility, or future option loss. A small absolute loss can eliminate a fragile actor's capacity to continue while a larger loss is absorbable elsewhere. A temporary disruption can be recoverable for one actor and permanently displacing for another. The practical meaning of risk depends on positional consequence.

Risk distribution can also be temporally separated. Present actors can obtain benefits while future actors inherit maintenance burdens, environmental exposure, institutional lock-in, debt, degraded capability, or narrowed options. Intergenerational risk therefore belongs within the same architecture even before the explicit justice analysis developed later in the chapter.

Definition 10.239 (Risk-bearing position). A *risk-bearing position* is a practical position characterized by a particular combination of exposure, consequence sensitivity, recovery capacity, voice, exit possibility, and temporal horizon in relation to a contemplated action or non-action.

A further issue concerns risk transfer. Insurance, contracting, outsourcing, delegation, regulation, or technical design can redistribute exposure. Transfer can improve practical resilience when risk moves toward actors better able to absorb or manage it. It can also obscure responsibility when exposure is shifted toward actors with less information or bargaining power. The analysis should therefore trace both formal allocation and effective burden.

Definition 10.240 (Risk-transfer pathway). A *risk-transfer pathway* is a relational mechanism through which exposure, liability, recovery cost, or uncertainty is shifted from one practical position to another without necessarily changing the underlying probability of the adverse event.

The distinction between probability reduction and burden transfer is important. A policy can make one actor appear safer by relocating exposure elsewhere. A contract can reduce one institution's liability without reducing system-level harm. A technical safeguard can protect a core function by sacrificing a peripheral subsystem. Distri-

butional analysis prevents these changes from being misidentified as unconditional risk reduction.

Proposition 10.241 (Positional adequacy of risk assessment). *A practical risk assessment is distributionally incomplete when it reports aggregate or average exposure without preserving materially different risk-bearing positions, recovery capacities, and future option losses.*

10.10.6 Tail Risk

Tail risk concerns adverse consequences located toward the extreme end of a consequence distribution or outside the range where empirical frequency is well established. The practical importance of tail risk increases when consequences are severe, propagation is possible, recovery is limited, or exposure is concentrated on actors with little capacity to absorb loss.

Definition 10.242 (Tail risk). *Tail risk* is a materially significant possibility of extreme adverse consequence whose likelihood is low, sparsely observed, structurally uncertain, or difficult to estimate relative to the consequence magnitude and practical stakes involved.

Tail risk can be statistical, structural, or both. In a well-observed system, rare events can occupy the extreme tail of a reasonably stable distribution. In a changing system, the tail itself can be poorly known because mechanisms, dependencies, or boundary conditions are shifting. The latter case requires particular caution with numerical extrapolation.

Extreme events also reveal model boundaries. A model calibrated around ordinary variation can perform well in the center of a distribution while failing under conditions that activate different mechanisms. Historical absence of a catastrophe therefore has limited evidential force when the system has changed or when the relevant event is intrinsically rare.

Definition 10.243 (Tail-exposure profile). A *tail-exposure profile* is an account of plausible extreme consequence classes, the mechanisms or structural conditions that could generate them, the positions exposed, the evidence supporting or limiting likelihood estimates, and the available capacities for containment and recovery.

Tail analysis should preserve plausibility discipline. Treating every imaginable catastrophe as equally decision-relevant would make practical orientation impossible. The analytical task is to identify materially plausible pathways, structural vulnerabilities, historical analogues, stress conditions, or failure combinations that justify attention even when frequency is poorly estimated.

The appropriate response can include exposure caps, reserves, containment, fallback systems, modularity, geographic or institutional diversification, independent monitoring, staged commitment, and explicit crisis authority. These measures often appear inefficient under ordinary conditions because they preserve capacity that may rarely be used. Their value lies partly in preventing extreme consequence from becoming unrecoverable.

Proposition 10.244 (Tail consequence and practical threshold). *Where a materially plausible adverse consequence is extreme and recovery capacity is limited, practical decision thresholds can reasonably depend on consequence severity and irreversibility in addition to estimated likelihood.*

The proposition connects tail risk to reversibility. A low estimated probability can still deserve substantial practical attention when the consequence would eliminate essential capacities or foreclose recovery pathways.

10.10.7 Reversible Action

Reversibility concerns the practical capacity to restore, reconstruct, or recover valued conditions after an intervention, commitment, or consequence. A reversible action therefore does not mean an action without cost or residue. It means that a sufficiently close practical return or alternative recovery pathway remains reachable within the relevant horizon and with acceptable burdens.

Definition 10.245 (Practical reversibility). *Practical reversibility* is the capacity to restore, reconstruct, or recover materially relevant relations, capabilities, conditions, rights, options, or functions after a practical commitment or consequence, within a specified temporal horizon and at burdens considered acceptable for the positions affected.

The definition is multidimensional. An action can be technically reversible while socially persistent. A software setting can be restored while trust remains damaged. A contract can be terminated while a displaced capability takes years to rebuild. A physical intervention can be repaired while ecological or cultural effects remain. Reversibility should therefore be assessed across the dimensions that matter to the practical situation.

Definition 10.246 (Recoverability profile). A *recoverability profile* is an account of which material, relational, institutional, epistemic, normative, and capability conditions can be restored after a practical commitment, by whom, over what time, at what cost, and with what residual change.

Reversible action is especially important under uncertainty because it can permit learning through bounded exposure. A pilot, temporary rule, modular installation, revocable authorization, or staged contract can generate information while preserving a pathway toward correction. The practical value of reversibility therefore includes epistemic value.

Reversibility also depends on governance. A technically reversible intervention can become practically irreversible if no actor has authority to reverse it, if institutional incentives resist rollback, if data needed for restoration are absent, or if beneficiaries of the new arrangement can block change. Reversibility is therefore partly a property of decision architecture.

Definition 10.247 (Rollback capacity). *Rollback capacity* is the effective combination of authority, knowledge, resources, procedures, records, and operational means required to reverse or materially repair a practical commitment after implementation.

A credible rollback plan should exist before the need for rollback emerges when the intervention is consequential and uncertainty is material. Otherwise, reversibility can become a nominal promise unsupported by practical capacity.

Proposition 10.248 (Reversibility as an epistemic resource). *Where bounded action can generate decision-relevant learning, practical reversibility can increase the warrant for experimentation by limiting the consequence of error while preserving the capacity to revise orientation.*

10.10.8 Partially Reversible Action

Many practical actions are neither fully reversible nor fully irreversible. Some dimensions can be restored while others persist. Recovery can be possible for some actors and unavailable to others. Reversal can become more difficult as time passes. A decision can restore formal rules while leaving material investments, expectations, capabilities, or relationships altered. Partial reversibility is therefore likely to be a common condition in application-dominant praxis.

Definition 10.249 (Partial reversibility). *Partial reversibility* is the condition in which some materially relevant consequences of a practical commitment can be restored or repaired within the relevant horizon while others remain persistent, costly, asymmetric, delayed, or inaccessible to one or more affected positions.

Partial reversibility can be dimensional. A technical system can be removed while data already disclosed remain outside control. A temporary institutional rule can expire while organizational routines persist. A land-use change can be physically altered while biodiversity recovery remains incomplete. A social decision can be formally reversed while reputational effects endure. These differences matter because a single label of “reversible” can hide durable consequences.

Partial reversibility can also be positional. An institution can recover financially while individuals exposed to the intervention cannot restore lost time, health, livelihood, trust, or opportunity. The decision-maker’s ability to reverse its own commitment therefore does not establish reversibility for everyone affected.

Definition 10.250 (Reversibility asymmetry). *Reversibility asymmetry* is a difference among affected positions in their capacity to recover, repair, exit, or reconstruct materially relevant conditions after the same practical commitment or consequence.

Temporal decay is another important feature. An action can be reversible during an early window and become increasingly difficult to reverse as complementary investments, dependencies, habits, standards, or expectations accumulate. Monitoring should therefore include changes in rollback cost and recoverability, not merely changes in performance.

Definition 10.251 (Reversibility window). A *reversibility window* is a temporally bounded interval during which restoration or redirection remains materially more feasible than it is expected to become after additional commitment, adaptation, or path formation.

This concept connects reversibility to urgency. Sometimes the urgent action is not expansion of the intervention but preservation of the ability to reverse it before the window closes.

Proposition 10.252 (Heterogeneous reversibility). *Where the dimensions, positions, or temporal windows of recovery differ materially, practical assessment should represent reversibility as a profile rather than classify the intervention through a single binary label.*

10.10.9 Irreversible Action

Irreversible action changes the practical field in ways for which a materially adequate return pathway is unavailable within the relevant horizon. Irreversibility can concern physical conditions, institutional commitments, lost lives or capabilities, ecological transformation, disclosure, destruction of records, elapsed opportuni-

ties, path-dependent infrastructures, or social relations whose prior form cannot be reconstructed. The concept therefore extends beyond permanence in a narrow physical sense.

Section 10.2.7 introduced practical irreversibility as the degree to which an action commits a relational configuration to consequences, dependencies, losses, or foreclosed possibilities that cannot be restored within the relevant horizon at acceptable practical cost. The present subsection extends that earlier formulation by making the dimensions and positions of irreversibility explicit.

Definition 10.253 (Irreversibility profile). An *irreversibility profile* is an account of which materially relevant consequences resist restoration or adequate compensation, the temporal horizon over which recovery is assessed, the positions affected, the practical capacities available for repair, and the future options altered by the commitment.

Irreversibility is horizon-dependent. Some ecological, institutional, or social changes may be reversible over centuries but effectively irreversible for the actors living through the relevant decision period. A lost opportunity can become irreversible when a deadline passes even though similar opportunities may later emerge. A destroyed record can be irrecoverable even when the institution that destroyed it continues to function. Practical analysis should therefore identify the horizon and the object of irreversibility.

Definition 10.254 (Irreversibility horizon). An *irreversibility horizon* is the temporal and practical boundary within which restoration, reconstruction, or adequate compensation would need to remain reachable for a consequence to count as reversible for the decision under consideration.

Irreversibility raises the required quality of practical justification because later correction becomes constrained. This does not imply a universal prohibition on irreversible action. Many valuable actions involve irreversible commitments: building institutions, protecting endangered systems, ending harmful practices, making promises, or acting within time-sensitive emergencies. The relevant issue is the relation among stakes, knowledge, participation, distribution, available alternatives, and the consequences of both acting and withholding action.

Irreversible action can also be path-creating. It can alter standards, expectations, infrastructures, competencies, identities, or dependencies so that later decisions occur within a transformed action space. The initial decision thereby shapes which future problems are visible and which solutions remain feasible.

Definition 10.255 (Path-creating commitment). A *path-creating commitment* is a practical commitment that materially changes the costs, capacities, institutions, expectations, or relations governing later action and thereby makes some future trajectories more reachable and others less reachable.

Path creation can be desirable when it establishes durable rights, protections, capabilities, or cooperative institutions. It can also generate harmful lock-in. The normative status cannot be inferred from irreversibility alone.

Proposition 10.256 (Irreversibility and practical justification). *As materially relevant recovery pathways narrow, practical justification should give increasing attention to epistemic sufficiency, affected positions, participation, tail consequences, alternative pathways, distribution of burden, and the consequences of foreclosing later revision.*

The proposition expresses a graded relation rather than a fixed threshold. Greater

irreversibility generally increases the importance of justification because error becomes harder to repair, while urgency or severe consequences of inaction can still support decisive commitment.

10.10.10 Option Preservation and Foreclosure

The final subsection connects risk and reversibility to the action-space architecture developed in Section 10.7. Practical decisions do more than produce immediate outcomes. They preserve some future possibilities, generate others, and foreclose alternatives. Option preservation is therefore a way of governing uncertainty through the future structure of agency.

Definition 10.257 (Option preservation). *Option preservation* is the practical maintenance of materially meaningful future alternatives, together with the capacities, knowledge, rights, resources, and institutional pathways required to keep those alternatives effectively reachable.

Preservation requires more than leaving a nominal choice formally open. An option can disappear through capability erosion, incompatible infrastructure, depleted resources, legal commitment, knowledge loss, institutional closure, or the expiration of a temporal window. Effective preservation therefore includes maintenance of the conditions needed to exercise the option later.

Several practical designs can preserve options. Modular systems can allow components to be changed without replacing the whole. Interoperable standards can reduce dependence on one pathway. Redundant capability can retain alternatives during disruption. Time-limited commitments can prevent provisional arrangements from becoming permanent by inertia. Data portability, archival continuity, transferable skills, diversified relationships, and preserved exit rights can all support later revision.

Definition 10.258 (Option-preservation profile). An *option-preservation profile* is an account of which future alternatives remain effectively reachable after a contemplated commitment, what capacities are required to maintain them, what costs preservation imposes, and which actors possess practical access to the preserved options.

Option preservation is not automatically desirable. Maintaining every possible alternative can consume resources, fragment coordination, delay beneficial commitment, or preserve harmful practices. Some options deserve deliberate foreclosure. Safety rules can remove dangerous actions. Rights can prohibit coercive pathways. Ecological limits can close exploitative possibilities. Institutions can stabilize cooperation by making certain defections costly. The practical question concerns which options are preserved or foreclosed, for whom, through which authority, and with what future consequences.

Definition 10.259 (Option foreclosure). *Option foreclosure* is the loss, prohibition, practical inaccessibility, or severe degradation of a future action pathway through present commitment, elapsed time, capability change, institutional design, material transformation, or relational restructuring.

Foreclosure can be explicit or emergent. A contract can formally prohibit an alternative. A technology can become so embedded that alternatives are prohibitively costly. A capability can disappear because it is no longer practiced. An ecosystem

can cross a threshold. A population can lose trust required for later cooperation. The practical record should therefore trace both formal closure and structural erosion.

Definition 10.260 (Foreclosure record). *A foreclosure record is a traceable account of the future alternatives expected to become less reachable or inaccessible through a practical commitment, the mechanism and horizon of that change, the positions affected, and the justification for accepting or pursuing the resulting closure.*

The distribution of option preservation matters as much as the total number of options retained. An institution can preserve strategic flexibility for itself by transferring rigidity to workers, communities, suppliers, or future administrations. A wealthy actor can retain exit while others become locked in. The practical evaluation should therefore ask whose future agency is preserved.

Option preservation also creates a bridge between uncertainty and generativity. Under incomplete knowledge, maintaining several viable pathways can support learning and adaptation. Under stable conditions, sustained openness can become costly and coordination can require commitment. Praxis therefore moves between openness and closure rather than maximizing either one universally.

Proposition 10.261 (Option-sensitive practical commitment). *Where uncertainty, reversibility, and future agency are materially relevant, practical evaluation should include the options that a commitment preserves, generates, degrades, or forecloses and the distribution of effective access to those options across affected positions.*

The proposition integrates the section. Known risk supports bounded estimation where the consequence structure is sufficiently characterized. Uncertain risk requires explicit retention of unresolved pathways and often a different architecture of commitment. Relational risk follows dependence, authority, information, and recovery across positions. Systemic risk traces propagation, feedback, and fragility across interconnected structures. Distributional analysis identifies who bears exposure, uncertainty, recovery cost, and option loss, while tail analysis gives practical attention to extreme consequences under sparse or unstable evidence. Reversibility then asks which consequences can be restored or repaired, for whom, and within which horizon. Partial reversibility preserves the heterogeneity of recovery, and irreversibility identifies consequences for which adequate return pathways are unavailable. Option preservation and foreclosure finally extend consequence analysis into the future action space.

This architecture prepares Section 275. Risk is never distributed independently of practical power. Actors differ in their capacity to define which risks count, to authorize exposure, to select protective thresholds, to transfer burdens, to shape measurements, to command recovery resources, and to preserve exit for themselves or others. The next section therefore examines power in praxis as a set of relational capacities that influence problem definition, end selection, decision, action, measurement, evaluation, withholding, and exit.

10.11 Power in Praxis

Sections 10.4–10.10 developed practical problem formation, judgment, ends, action spaces, decision under incomplete knowledge, action and non-action, risk, and irreversibility. Each of these structures can be distributed unevenly across the actors and institutions that compose a practical situation. The present section examines that un-

evenness through the concept of power. Its role is to identify the points at which some positions can shape the constitution, direction, execution, interpretation, and revision of praxis more strongly than others. The objective is to distinguish power to define the problem, select the end, decide, act, withhold action, measure, evaluate, and exit, and then to explain how broader asymmetries can become practically consequential power. The discussion remains domain-general. Power is treated relationally and positionally, with attention to the mechanisms through which capacities become effective in a particular practical field.

Power enters application-dominant praxis before any visible intervention occurs. It can influence which conditions receive attention, whose descriptions become authoritative, which ends are treated as legitimate, which options enter the action space, which uncertainties receive protection, which risks are accepted, which measurements become official, and which consequences trigger revision. Power can also operate through absence: an actor may possess the capacity to delay, veto, withdraw resources, withhold cooperation, decline measurement, or exit while others remain exposed to the consequences. These capacities can be formal, informal, material, institutional, epistemic, symbolic, infrastructural, or relational.

Definition 10.262 (Practical power). *Practical power* is a situated capacity of an actor, collective, institution, or relational position to alter the constitution, direction, execution, interpretation, or revision of consequential praxis, including the practical possibilities available to other positions.

The definition emphasizes capacity and practical effect. Formal authority can contribute to practical power, while authority alone does not establish that an intended effect can be realized. Material resources can support power, while resources become practically powerful only through usable pathways of access, coordination, legitimacy, knowledge, or enforcement. Dependency can increase one actor's leverage over another, while its practical effect depends on available alternatives, exit capacity, and the temporal structure of the relation. Practical power therefore belongs to a relational configuration rather than to an isolated possession.

Power also has a generative dimension. An exercise of power can alter later capabilities, dependencies, categories, expectations, institutions, and action spaces. A decision can create a standard that later actors must follow. Control over infrastructure can shape future access. A measurement regime can stabilize categories through which later decisions are made. An exit by one actor can reorganize the bargaining position of those who remain. Practical power is therefore relevant both to immediate action and to the production of future conditions of action.

Table 10.11 separates several loci that are frequently compressed into a single image of decision authority. Their separation matters because power can be distributed differently at each locus. One actor can define the problem while another formally decides. A third can control implementation. A fourth can determine what counts as success. A fifth can exit if the arrangement becomes unfavorable, leaving others to absorb residual costs. Practical analysis therefore benefits from mapping the sequence through which influence becomes consequential.

Definition 10.263 (Practical power profile). A *practical power profile* is a stage- and relation-specific account of which positions can shape problem formation, ends, decisions, implementation, withholding, measurement, evaluation, exit, and the future distribution of these capacities.

A power profile is indexed to a practical situation. It can change when institutions,

Table 10.11: Principal loci of power in application-dominant praxis.

Locus	Practical object	Characteristic mechanism	Characteristic concern
Problem definition	Boundary, salience, category, causal account	Agenda control, classification, expertise, recognition, omission	Some conditions or positions become central while others remain peripheral or invisible
End selection	Valued direction of praxis	Mandate, priority setting, agenda formation, value authorization	Particular values and futures acquire coordinating force
Decision	Commitment among alternatives	Formal authority, veto, procedure, delegation, emergency competence	Decision rights can diverge from exposure to consequences
Action	Implementation and transformation	Resources, infrastructure, access, coordination, enforcement, capability	Formal decisions can have unequal practical executability
Withholding	Delay, veto, non-cooperation, resource retention	Refusal, budget control, non-authorization, procedural delay, abstention	Absence of action can preserve or intensify existing relations
Measurement	Visibility and comparability	Indicator design, data access, category definition, sampling, standards	What is measurable can shape what becomes actionable
Evaluation	Interpretation of consequence and success	Benchmarks, attribution rules, review authority, audit, narrative control	Evaluation can stabilize or reopen prior commitments
Exit	Continuation of relation	Mobility, portability, substitution, legal right, resource independence	Exit capacity can redistribute bargaining power and residual burden
Asymmetry conversion	Unequal position within the practical field	Dependence, scarcity, coordination, legitimacy, information, timing	An asymmetry becomes power when a usable pathway connects it to practical consequence

resources, knowledge, alliances, infrastructures, legal competences, or exit possibilities change. It can also differ by stage. A community can possess strong problem-recognition capacity and weak decision authority. A regulator can possess formal decision power while depending on information generated by the actors it regulates. An organization can control implementation but lack authority to redefine the end. Such distributions are central to later questions of participation, responsibility, and justice.

10.11.1 Power to Define the Problem

Section 10.4 treated a practical problem as a revisable representation formed from a wider practical situation. Power enters this process through the capacity to influence what receives salience, how boundaries are drawn, which histories are considered relevant, whose categories become authoritative, and which causal accounts structure the response. The power to define the problem is therefore an upstream form of practical power. It can shape later ends and decisions before alternatives are formally compared.

Definition 10.264 (Problem-definition power). *Problem-definition power* is the situated capacity to influence the salience, boundaries, categories, causal accounts, affected positions, temporal horizon, and response-relevant representation through

which a practical condition becomes organized as a problem.

Problem-definition power can operate through agenda setting. Some conditions enter meetings, reports, budgets, and public deliberation while others remain outside the practical agenda. It can operate through categorization. A condition described as a technical malfunction invites a different response architecture from the same condition described as an institutional coordination failure, a capability deficit, a rights concern, or a historical dependency. It can operate through scale selection. A local framing can obscure system-level propagation, while a system-wide framing can flatten local differences. It can operate through temporal framing when short-horizon stabilization receives attention while slow accumulation remains peripheral.

The capacity to define a problem is distributed across multiple sites. Affected actors can introduce experiences unavailable to formal decision-makers. Technical specialists can characterize mechanisms and constraints. Institutions can determine official categories. Data systems can make some populations visible while leaving others weakly represented. Media, professional communities, legal procedures, and organizational routines can affect salience. The practical field can therefore contain several competing centers of problem-definition power rather than one sovereign source.

Problem-definition power is especially consequential when later action is path-dependent. Early framing can determine what evidence is collected, which interventions are funded, and which actors are treated as relevant participants. These choices can produce feedback. Once measurement systems, institutional mandates, or professional routines are organized around a formulation, alternative formulations may become more costly to introduce. The initial problem representation can thereby acquire persistence beyond the evidence that originally supported it.

Definition 10.265 (Problem-framing leverage). *Problem-framing leverage* is the degree to which influence over an early problem representation shapes later evidence collection, end selection, option generation, institutional attention, or resource commitment.

High framing leverage increases the practical importance of contestability and revision. A formulation with large downstream consequences warrants explicit provenance: who introduced it, which evidence and experiences supported it, which alternatives were considered, and what would justify reopening it. This requirement does not imply that every practical problem admits unlimited framing. Some formulations can be poorly supported, internally inconsistent, or materially insensitive to observed consequences. Contestability is compatible with disciplined evaluation of competing formulations.

Proposition 10.266 (Upstream leverage of problem definition). *Where problem formulation materially shapes evidence collection, end selection, and option generation, unequal capacity to define the problem can generate downstream practical power even when formal decision rights are distributed elsewhere.*

The proposition prepares Section 10.12, where participation and representation are examined as responses to distributed agency. For the present section, the analytical requirement is narrower: a power analysis should identify who can make a condition practically legible and whose accounts require additional effort, translation, authorization, or evidence before entering the decision process.

10.11.2 Power to Select the End

Section 10.6 treated ends as provisionally specified valued conditions, relations, capabilities, processes, or transformations toward which praxis is organized. Power enters when some actors possess greater capacity to determine which of several values or futures acquires coordinating force. The power to select the end concerns practical orientation rather than implementation alone.

Definition 10.267 (End-selection power). *End-selection power* is the situated capacity to establish, prioritize, rank, sequence, or exclude practical ends in ways that materially orient subsequent decision and action.

End-selection power can arise from formal mandate. A governing body can possess authority to adopt a mission or policy objective. It can arise from ownership or resource control when funding is conditional on a specified end. It can arise from expertise when technical feasibility determines which aspirations are treated as realistic. It can arise from institutional tradition when inherited goals possess default legitimacy. It can also arise through agenda control when one value enters formal deliberation while another remains represented only indirectly.

The selection of ends can redistribute future agency. An end centered on rapid completion can compress opportunities for participation. An end centered on standardization can reduce local discretion. An end centered on resilience can justify redundancy that would appear inefficient under a narrower objective. An end centered on preserving future option space can favor staged commitment. These differences illustrate why ends are practically constitutive: they organize which consequences count as success, which trade-offs become visible, and which capabilities receive investment.

Power over ends also operates through the specification of their level of abstraction. Broad ends such as safety, dignity, learning, sustainability, or institutional reliability require interpretation before they guide action. More operational ends specify thresholds, populations, timescales, or institutional responsibilities. Actors who control this translation can shape praxis even when the higher-level value is widely shared.

Definition 10.268 (End-specification leverage). *End-specification leverage* is the capacity to translate a broadly accepted value or orientation into operational ends, priorities, thresholds, and temporal horizons that guide concrete action.

End-selection power therefore deserves separate analysis from normative agreement. A group can agree that a value matters while disagreeing about which practical end expresses it. Likewise, actors can endorse the same end in language while attaching different temporal horizons, burden distributions, or revision conditions. Recording these specifications helps prevent apparent consensus from obscuring materially different orientations.

The revisability of ends introduced in Section 10.6 also has a power dimension. Some actors can reopen ends when consequences change, while others can only adapt within an inherited objective. A practical power profile should therefore include both the capacity to establish ends and the capacity to trigger their revision.

Proposition 10.269 (Power through end specification). *Where broad values require operational translation, influence over the specification, sequencing, and revision of practical ends can shape later action even when the underlying value commitment is widely shared.*

10.11.3 Power to Decide

Decision power concerns the capacity to convert a set of considered possibilities into an authorized commitment. Section 10.8 treated decision as provisional commitment under incomplete knowledge. The present subsection adds a positional question: who can make, approve, veto, ratify, delegate, or reopen that commitment?

Definition 10.270 (Decision power). *Decision power* is the situated capacity to authorize, block, ratify, delegate, condition, or reopen a practical commitment among available or generated alternatives.

Decision power is often institutionally explicit. Constitutions, contracts, organizational charters, professional rules, emergency procedures, and delegated mandates can specify who decides. Practical decision power, however, can diverge from formal allocation. An actor with nominal authority can depend on another actor for information, implementation, budget, legal interpretation, or political support. Conversely, an actor without formal authority can acquire effective veto power through indispensability, control of a critical resource, or capacity to impose high coordination costs.

This distinction can be recorded through a decision-authority profile.

Definition 10.271 (Decision-authority profile). A *decision-authority profile* maps formal decision rights, effective veto points, delegation relations, information dependencies, approval requirements, emergency competences, and reopening pathways for a practical commitment.

The profile also clarifies the relation between authority and exposure. The actors authorized to decide can differ from those who bear the principal risks described in Section 10.10. This divergence does not by itself determine legitimacy, because practical arrangements can require representation, expertise, delegation, or division of labor. It does create a question that later sections on participation, responsibility, and justice must address: how are decision rights related to affected positions, knowledge, accountability, and capacity for revision?

Decision power can also be temporal. Emergency authority can concentrate decision capacity for a limited period. Sunset clauses can return authority after stabilization. Sequential approval can distribute power across stages. Pilot authorization can permit limited commitment while reserving later expansion to another body. These structures show that decision power can be designed rather than treated as a fixed possession.

Definition 10.272 (Decision-power temporality). *Decision-power temporality* is the distribution of decision authority across stages, durations, triggering conditions, review points, and reopening events within a practical process.

A decision system can therefore balance speed and distributed control in several ways. Urgent stabilization may require concentrated authority, while durable structural commitment may require broader review. Reversible pilots can be authorized at a lower threshold than irreversible expansion. The appropriate architecture depends on consequence, uncertainty, urgency, and reversibility rather than on one universal model of decision.

Proposition 10.273 (Decision power and consequence exposure). *Where decision authority and consequence exposure occupy different practical positions, analysis of the decision should preserve both the authorization structure and the distribution of risk,*

recovery capacity, and revision rights.

10.11.4 Power to Act

The power to decide does not guarantee the power to act. Implementation requires effective capacities: resources, knowledge, infrastructure, access, coordination, legal competence, organizational routines, labor, technology, and often the cooperation of other actors. Section 10.7 described effective action space as a function of reachability. Power to act concerns unequal capacity to convert authorized possibilities into material or relational transformation.

Definition 10.274 (Action power). *Action power* is the situated capacity to mobilize the resources, capabilities, access, coordination, authority, and infrastructures required to transform an authorized or intended practical possibility into consequential intervention.

Action power can be concentrated even when decision power is distributed. A collective body can formally authorize an intervention while a small operational unit controls execution. It can also be fragmented. Several actors may each control a necessary component, making action dependent on coordination. In such cases practical power can arise from complementarity: an actor becomes powerful because its contribution is difficult to substitute within the relevant time window.

Implementation also contains discretion. Written decisions rarely specify every local adjustment, sequence, exception, or interpretation. Front-line actors, technical operators, contractors, administrators, and coordinating institutions can therefore exercise power through implementation choices. Their discretion can improve adaptation when local knowledge is important. It can also reshape the intervention away from the assumptions under which it was authorized. A power analysis should therefore preserve the translation from decision to action.

Definition 10.275 (Implementation discretion). *Implementation discretion* is the practical latitude available to actors who translate an authorized commitment into concrete sequences, allocations, classifications, exceptions, and interactions.

Action power includes the capacity to sustain intervention through time. A short mobilization can be easier than maintaining staffing, financing, infrastructure, monitoring, and repair. Durable power therefore depends partly on maintenance capability. This temporal dimension is especially important when interventions create dependencies that outlast the initial decision.

Action power can also generate future power. Infrastructure built for one purpose can become a platform for later intervention. Organizational learning can increase coordination capacity. Successful implementation can create legitimacy, standards, or network position. Conversely, failed implementation can erode trust, resources, or authority. Power is therefore dynamically generated and depleted through praxis.

Definition 10.276 (Power-generating implementation). *Power-generating implementation* is an intervention whose execution materially changes the later capacity of one or more positions to define, decide, act, withhold, measure, evaluate, or exit.

This definition prepares the later analysis of institutional and collective praxis. It also prevents action power from being treated as a static stock. Practical capabilities can accumulate, decay, diffuse, or become dependent on infrastructures and relations created by earlier interventions.

Proposition 10.277 (Implementation as a locus of power). *Where concrete execution requires interpretation, sequencing, coordination, and local adaptation, the distribution of implementation capacity can materially reshape an authorized decision and its later power structure.*

10.11.5 Power to Withhold Action

Section 10.9 developed non-action as a family of practical forms. Power analysis adds a further distinction: the capacity to withhold action can itself be unevenly distributed. Some actors can delay approval, retain resources, refuse cooperation, suspend service, decline information, or preserve optionality while others continue to bear the consequences of the existing situation.

Definition 10.278 (Withholding power). *Withholding power* is the situated capacity to alter a practical process by delaying, declining, suspending, retaining, or conditioning an action, resource, authorization, cooperation, or contribution whose absence is consequential for other positions.

Withholding power can be formal, as with a veto or approval requirement. It can be material, as when an actor controls a scarce resource. It can be informational, as when necessary data or expertise are not supplied. It can be organizational, as when participation in coordination is indispensable. It can also arise from temporal asymmetry. An actor able to wait can possess leverage over an actor facing urgent loss.

This temporal dimension deserves explicit attention.

Definition 10.279 (Temporal leverage). *Temporal leverage* is practical power generated by unequal capacities to wait, absorb delay, accelerate commitment, or impose time costs within a consequential relation.

Temporal leverage connects power to urgency. Section 10.8 treated urgency as a property of how delay changes consequences and option spaces. When actors experience different costs of delay, the actor with greater temporal resilience can often demand concessions, defer commitment, or preserve alternatives unavailable to others. The resulting power does not require explicit coercion; it can arise from the structure of time-sensitive dependence.

Withholding power also has a collective form. Coordinated refusal can interrupt a process that individual refusal would barely affect. Conversely, fragmented actors may possess little individual leverage even when their combined contribution is essential. Organization and coordination can therefore convert diffuse capacity into practical power.

The consequences of withholding require the same distributional analysis used for action. Withholding can protect against poorly warranted intervention. It can preserve rights, autonomy, or safety. It can also prolong exposure, entrench an existing asymmetry, or transfer costs toward actors with weaker reserves. Its practical meaning depends on the relation, the reasons for withholding, available alternatives, and who bears the consequences of delay.

Proposition 10.280 (Power through consequential absence). *Where the absence of an actor's authorization, resource, cooperation, information, or contribution materially changes another position's practical possibilities, capacity to withhold that contribution constitutes a form of practical power.*

10.11.6 Power to Measure

Measurement is a locus of power because application-dominant praxis depends on representations of conditions, performance, risk, burden, progress, and consequence. The capacity to determine what is measured, how categories are defined, where data are collected, which populations are represented, and which uncertainties remain visible can shape what later actors treat as practically real.

Definition 10.281 (Measurement power). *Measurement power* is the situated capacity to shape the categories, indicators, data-generating procedures, standards, observation boundaries, and evidential infrastructures through which a practical situation and its consequences become quantitatively or qualitatively represented.

Measurement power begins with category formation. Categories can determine which differences become visible and which are aggregated. It continues through indicator choice. A proxy can foreground one dimension of performance while leaving another weakly represented. It operates through sampling and access, because some actors, events, or spaces can be easier to observe than others. It also operates through technical standards, metadata, interoperability, and archival practices that determine which observations can travel across institutions and time.

Measurement power should be distinguished from fabrication or manipulation. A measurement regime can be technically competent and still exercise power because every practical representation selects dimensions, resolutions, categories, and boundaries. The relevant question is therefore how these selections are made, whose positions they represent, which uncertainties they retain, and how readily the system can be revised when consequences escape its categories.

Definition 10.282 (Measurement regime). A *measurement regime* is the organized configuration of categories, indicators, instruments, observation practices, data access, standards, validation procedures, and reporting conventions through which a practical field becomes evidentially represented.

Measurement regimes can acquire path dependence. Once budgets, targets, contracts, audits, and professional routines depend on an indicator, revision becomes costly. Actors can adapt their behavior to what is measured. The measure can thereby participate in changing the practical situation it represents. This generative feedback is especially important when performance indicators influence resource allocation or legitimacy.

Measurement also affects distribution. Actors with strong data infrastructure can make their conditions visible in forms readily accepted by institutions. Actors whose experiences are difficult to encode can require additional translation or advocacy before their conditions enter formal analysis. Qualitative testimony, local knowledge, and interpretive evidence can therefore be practically important complements where standardized metrics have limited reach.

Definition 10.283 (Measurement contestability). *Measurement contestability* is the practical capacity to question, supplement, reinterpret, or revise the categories, indicators, data boundaries, and validation procedures used to represent a practical situation.

Contestability does not require permanent instability of measurement. Stable measures are often necessary for coordination and comparison. The aim is to preserve pathways for revision when the measure systematically omits consequential dimensions or begins to govern behavior in ways that undermine the practical end.

Proposition 10.284 (Measurement as practical intervention). *Where measurement structures attention, resource allocation, accountability, or behavior, the design and maintenance of the measurement regime form part of application-dominant praxis rather than a neutral stage external to it.*

10.11.7 Power to Evaluate

Measurement provides representations; evaluation assigns practical significance to those representations. Evaluation power concerns the capacity to determine whether an intervention is treated as successful, acceptable, harmful, incomplete, or in need of revision. It therefore influences continuation, scaling, termination, compensation, institutional learning, and historical memory.

Definition 10.285 (Evaluation power). *Evaluation power* is the situated capacity to shape the criteria, benchmarks, attribution rules, evidential interpretations, temporal horizons, and review procedures through which practical consequences are judged and prior commitments are continued, revised, or closed.

Evaluation power begins with criteria. An intervention can look successful under one criterion and problematic under another. Immediate output can improve while long-horizon capability declines. Aggregate benefit can rise while burdens concentrate. A target can be met while the underlying problem representation becomes obsolete. The choice of evaluative criteria therefore connects directly to the ends specified in Section 10.6.

Evaluation power also operates through attribution. Consequences emerge from multiple interacting processes. Evaluators decide, explicitly or implicitly, which changes count as effects of the intervention, which are attributed to external conditions, and which remain uncertain. These choices affect responsibility and learning. Over-attribution can exaggerate effectiveness; under-attribution can obscure harm or contribution. A disciplined evaluation should preserve uncertainty about causal contribution where the evidence remains incomplete.

Temporal horizon is another locus of evaluative power. Early evaluation can privilege immediate effects. Late evaluation can miss harms borne by actors who have already exited or disappeared from the data. Short review cycles can favor interventions with rapid measurable outputs over slower capability formation. Long-horizon analysis can reveal path dependence and maintenance burdens that initial assessments could not observe.

Definition 10.286 (Evaluation frame). An *evaluation frame* is the specified combination of evaluative criteria, comparison baselines, attribution rules, affected positions, evidence standards, temporal horizons, and revision triggers used to judge practical consequence.

Evaluation frames can themselves be contested and revised. Independent review, plural indicators, affected-subject testimony, counterfactual comparison, longitudinal observation, and explicit uncertainty records can broaden the evaluative field. The appropriate combination depends on the practical problem and the consequence structure.

Evaluation power is especially consequential when it feeds back into legitimacy and resource allocation. An institution that evaluates its own success can possess strong incentives and informational advantages. External evaluators can increase

independence while lacking local knowledge. Participatory evaluation can broaden experience while introducing coordination and representation challenges. The problem is therefore architectural: how should evaluation authority, evidence access, and contestability be distributed for the practical stakes at issue?

Definition 10.287 (Evaluation-revision power). *Evaluation-revision power* is the capacity to use evaluative findings to trigger continuation, scaling, redesign, suspension, repair, compensation, or reopening of a practical commitment.

This concept distinguishes evaluative voice from practical consequence. An actor can produce a critical evaluation while lacking authority to alter the intervention. Conversely, a decision-maker can possess reopening authority while lacking direct access to the evidence needed to recognize failure. Effective accountability later in the chapter will require connection between evaluation, traceability, and revision capacity.

Proposition 10.288 (Evaluation power and practical memory). *Where evaluations determine which consequences are officially recorded, attributed, and carried forward into later decisions, evaluation power contributes to the practical memory through which future praxis is organized.*

10.11.8 Power to Exit

Section 10.9 treated exit as termination or substantial severance of participation in a relation, institution, process, or arrangement. Power analysis focuses on unequal capacities to exercise exit and on the effects that credible exit can have before departure occurs. Exit power therefore includes both realized departure and bargaining leverage generated by the practical availability of departure.

Definition 10.289 (Exit power). *Exit power* is the situated capacity to leave, substitute away from, or materially reduce dependence on a practical relation in ways that alter one's own exposure or the bargaining and consequence structure of the relation.

Exit power depends on more than formal permission. Effective exit can require mobility, portable rights, alternative providers, independent resources, transferable credentials, information, social support, legal status, technical interoperability, or recoverable assets. A right of exit with prohibitive transition cost can provide little practical leverage. Section 10.7 therefore remains relevant: exit belongs to the effective action space only where it is reachable under the actor's actual conditions.

The credibility of exit can affect negotiation without being exercised. An actor with multiple alternatives can resist unfavorable terms. An actor whose departure would remove a scarce capability can obtain concessions. Conversely, actors with high switching costs or few substitutes can become locked into relations even when formal exit remains available.

Definition 10.290 (Exit asymmetry). *Exit asymmetry* is a difference between practical positions in the cost, feasibility, timing, or consequence of leaving a relation or replacing the counterpart on which the relation depends.

Exit asymmetry can generate dependency power. A relation in which one actor can leave easily while another cannot can produce bargaining leverage even in the absence of explicit threat. This leverage is especially strong when the dependent actor faces urgent needs, limited substitutes, or irreversible loss during transition.

Exit also redistributes residual burden. When a powerful actor leaves, mainte-

nance costs, liabilities, knowledge gaps, infrastructure, or risk can remain with those who cannot exit. Exit can therefore improve one position's action space while contracting another's. A practical assessment should record who inherits residual obligations and whether the departing actor retains responsibility for consequences already generated.

Exit capacity can also be protective. The availability of exit can reduce domination, create competition, enable experimentation, and discipline institutions that otherwise face weak feedback. Yet some collective goods depend on durable cooperation, and easy exit by advantaged actors can undermine shared capacities. The practical value of exit therefore depends on the relation and on the institutional architecture surrounding departure.

Definition 10.291 (Residual-burden profile of exit). *A residual-burden profile of exit records the liabilities, maintenance duties, risks, capability losses, stranded resources, and coordination burdens that remain distributed among other positions after an actor leaves or materially reduces participation.*

Proposition 10.292 (Exit capacity and bargaining structure). *Where dependence is asymmetric, differences in feasible exit and substitution can alter bargaining power before exit occurs and can redistribute substantial burdens if exit is exercised.*

10.11.9 Conversion of Asymmetry into Practical Power

The preceding subsections identify several loci at which practical power can operate. They also reveal a more general question: how does an asymmetry become power? Actors differ in resources, information, legal status, organizational position, legitimacy, mobility, expertise, visibility, time horizon, network centrality, and access to infrastructure. These differences can matter greatly, yet an asymmetry becomes practically powerful only when a conversion pathway connects the difference to the capacity to shape consequential praxis.

Definition 10.293 (Practical asymmetry). *A practical asymmetry is a consequential difference between positions in resources, capabilities, information, authority, dependence, access, timing, legitimacy, mobility, visibility, coordination, or another condition relevant to praxis.*

Definition 10.294 (Power-conversion pathway). *A power-conversion pathway is a relational mechanism through which a practical asymmetry becomes effective capacity to shape problem definition, ends, decisions, action, withholding, measurement, evaluation, exit, or the future action spaces of other positions.*

The conversion requirement matters because possession and effect are distinct. Expertise becomes power when institutions defer to expert categories, when alternatives require technical certification, or when specialist knowledge controls access to action. Wealth becomes power when resources can purchase scarce capability, sustain delay, finance organization, secure alternatives, or condition participation. Network centrality becomes power when coordination depends on passage through a node. Legal authority becomes power when rules are enforceable and institutional actors recognize the competence. Social legitimacy becomes power when it mobilizes cooperation or constrains what decision-makers can sustain.

Power conversion is therefore mediated by institutions and relations. The same asymmetry can have different effects across settings. Information advantage can mat-

ter little where independent verification is cheap and rapid, while becoming decisive where verification is costly and decisions are urgent. Resource advantage can matter less where essential services are guaranteed, while becoming powerful where access depends on private provision. Formal authority can weaken where implementation is fragmented, while informal coordination capacity becomes decisive.

Definition 10.295 (Conversion condition). A *conversion condition* is a relational, institutional, material, temporal, or epistemic feature that enables, amplifies, constrains, redirects, or blocks the transformation of a practical asymmetry into effective power.

Several recurrent conversion conditions can be distinguished. *Dependence* increases the consequence of another actor's choices. *Scarcity* reduces substitutability. *Urgency* can increase the value of immediate access. *Coordination centrality* can make one position necessary for collective action. *Legitimacy* can transform claims into compliance. *Opacity* can protect informational advantage. *Standardization* can make control over a standard consequential across many actors. *Lock-in* can increase the cost of switching. *Institutional recognition* can convert formal status into enforceable authority. These conditions often interact.

Power conversion can also be cumulative. An initial advantage can generate resources that strengthen later advantages. Control over measurement can shape evaluation; favorable evaluation can increase legitimacy; legitimacy can expand decision authority; authority can direct resources; resources can increase implementation capacity. Such sequences create reinforcing power trajectories. Other architectures can interrupt them through independent review, interoperability, distributed capability, transparency, redundancy, contestability, or protected exit.

Definition 10.296 (Power-conversion chain). A *power-conversion chain* is a temporally ordered sequence in which one practical asymmetry is converted into a form of power that generates or amplifies additional asymmetries and later power capacities.

The possibility of conversion chains gives power a historical structure. Present power can contain accumulated effects of earlier decisions, infrastructures, classifications, property arrangements, institutional mandates, educational access, or technological standards. A snapshot of current authority can therefore understate the generative history through which the position became powerful. Conversely, present asymmetry need not be durable when conversion conditions are changing.

Practical power can also remain latent. An actor may possess a capacity that becomes relevant only under specific conditions: emergency authority activates after a threshold; a supplier's leverage increases when inventories fall; exit power rises when alternatives become available; data control becomes consequential when a new reporting regime is introduced. The relevant analysis should therefore identify both exercised power and plausible activation pathways.

Definition 10.297 (Latent practical power). *Latent practical power* is a presently unexercised capacity whose conversion into consequential influence becomes reachable under specified changes in dependence, scarcity, authority, coordination, timing, information, or institutional conditions.

The conversion perspective also helps distinguish asymmetry from domination. Unequal capacity deserves analysis whenever it shapes practical possibility, while normative assessment depends on how that capacity is constituted, constrained, exercised, contested, and distributed. Some asymmetries are functionally useful: specialized expertise, emergency coordination, or delegated authority can increase col-

lective capacity. Their practical acceptability depends partly on scope, accountability, contestability, reversibility, and the relation between authority and affected positions. These questions are developed more directly in Sections 10.12–10.14.

Proposition 10.298 (Conversion of asymmetry into power). *A practical asymmetry becomes effective power when a relational pathway connects that asymmetry to consequential influence over the constitution, direction, execution, interpretation, revision, or future possibility structure of praxis.*

Caution 10.299 (Power inference from observable advantage). Observable advantage provides evidence about possible power while leaving the conversion pathway to be established. Analysis should identify the mechanism through which the advantage changes practical possibilities, dependence, authority, or consequence rather than inferring effective power from the advantage alone.

This section has treated power as distributed across the practical sequence rather than concentrated only at the moment of formal decision. Power can shape what becomes a problem, which ends organize action, whose decision becomes binding, which interventions are executable, who can impose delay, what becomes visible through measurement, how consequence is evaluated, and who can leave while others remain. It can also reshape its own future distribution by generating new dependencies, infrastructures, capabilities, standards, and action spaces.

The resulting architecture raises an immediate question of agency. Once practical power is recognized as distributed across problem formation, knowledge, decision, implementation, evaluation, and exit, application-dominant praxis must determine how affected subjects and other relevant actors enter those processes. Participation cannot be treated solely as attendance at a decision point, because practical agency is exercised across the entire sequence. Section 10.12 therefore turns to participation and distributed agency, examining affected subjects, stakeholders, representation, voice, collective agency, unequal participation, and contestability.

10.12 Participation and Distributed Agency

Section 10.11 showed that practical power can be exercised throughout the sequence of application-dominant praxis: in problem definition, end selection, formal decision, implementation, withholding, measurement, evaluation, and exit. The present section develops the corresponding architecture of participation and agency. Its role is to specify how subjects, collectives, and institutions enter consequential praxis when affectedness, knowledge, authority, capability, and exposure are distributed across different positions. The objective is to distinguish affected subjects, stakeholders, participation, representation, voice, distributed decision-making, collective agency, unequal participation, and contestability, and to clarify the relations among these categories. The analysis remains domain-general and relational. Participation is treated as a stage-specific practical relation whose meaning depends on what participants can contribute, influence, authorize, contest, implement, observe, and revise.

Application-dominant praxis frequently involves actors whose practical relations to an intervention differ substantially. Some positions bear direct consequences. Others possess relevant knowledge. Some provide resources or implementation capacity. Some exercise delegated authority. Others maintain infrastructure, represent absent positions, or absorb residual burdens after a decision. These relations can overlap

within one actor and can change over time. A useful participation architecture therefore begins with relational position rather than with a single undifferentiated category of participant.

Participation also has a generative dimension. A participatory arrangement can change later knowledge, trust, coordination capacity, institutional memory, bargaining position, representational categories, and the action spaces described in Section 10.7. It can generate collective capabilities that were initially absent. It can also consume scarce time, expose participants to risk, stabilize particular representatives, or create procedural dependencies. Participation is therefore part of the practical intervention itself whenever it materially changes the relations through which later action is organized.

Definition 10.300 (Participation architecture). A *participation architecture* is the organized configuration of affected positions, stakeholders, representational relations, voice pathways, decision rights, collective capacities, participation burdens, and contestability mechanisms through which actors enter, influence, enact, observe, and revise application-dominant praxis.

Table 10.12 summarizes the main elements developed below. Their separation matters because a practical system can be strong in one dimension and weak in another. A process can invite broad participation while preserving concentrated decision rights. It can provide representation while leaving voice weakly heard. It can distribute decision authority while lacking collective capacity to coordinate implementation. It can permit objections while making review practically inaccessible. Participation analysis therefore benefits from following the entire architecture rather than counting participants or procedural opportunities alone.

10.12.1 Affected Subjects

The first positional category concerns subjects whose conditions are materially altered by praxis. Section 10.10 showed that exposure to risk, reversibility, and recovery capacity can be distributed unevenly. Section 10.11 further showed that decision authority and exposure can occupy different positions. The concept of an affected subject identifies this consequence-bearing relation without presuming that the subject possesses formal authority, recognized stakeholder status, or direct access to the process through which the consequence is produced.

Definition 10.301 (Affected subject). An *affected subject* is a person, collective, community, organization, or other practically relevant subject-position whose capabilities, relations, burdens, benefits, risks, rights, dependencies, environments, future options, or conditions of action are materially altered by an intervention, non-action, institutional arrangement, or practical trajectory.

Affectedness can arise through direct contact with an intervention, through propagation across relations, or through slower generative effects. A person can be affected because a service changes immediately. A community can be affected through altered access to infrastructure. A later population can inherit environmental, institutional, or technological consequences. An organization can absorb maintenance duties created by an earlier decision. A subject can also be affected through loss of an option, increased dependency, changed classification, or altered capacity to exit. The category therefore extends beyond immediate recipients of an intervention.

The degree and form of affectedness are also multidimensional. Magnitude mat-

Table 10.12: Principal elements of participation and distributed agency in application-dominant praxis.

Element	Practical relation	Characteristic contribution	Characteristic concern
Affected subjects	Exposure to consequence	Experience, situated knowledge, articulation of burden, benefit, capability, and option change	Some affected positions may be weakly visible, temporally distant, or unable to participate directly
Stakeholders	Consequential relation to praxis	Knowledge, authority, resources, responsibility, implementation, maintenance, dependence, or affectedness	Stakeholder status can differ in kind and does not by itself establish equal standing over every practical question
Participation	Entry into practical stages	Information, interpretation, value articulation, proposal, decision, implementation, monitoring, or revision	Formal access can diverge from effective influence and from the burdens of participation
Representation	Acting or speaking for other positions	Aggregation, delegation, continuity, translation, coordination, advocacy	Mandate, accountability, feedback, substitution, and representational distance require explicit treatment
Voice	Communicable practical expression with uptake pathways	Experience, claim, objection, proposal, warning, dissent, local knowledge	Expression can remain practically weak when reception, translation, protection, or response capacity is absent
Distributed decision-making	Allocation of decision rights across positions, stages, or scales	Local adaptation, differentiated expertise, shared authority, redundancy, staged commitment	Fragmentation, conflict, unclear escalation, and responsibility gaps can impair coordination
Collective agency	Coordinated capacity to form and sustain joint praxis	Shared orientation, coordination, memory, implementation, learning, revision	Collective capacity can vary across stages and can obscure internal asymmetries when treated as unitary
Unequal participation	Uneven practical capacity to enter and influence praxis	Reveals differences in time, safety, resources, language, expertise, recognition, and procedural access	Equal formal invitation can coexist with sharply unequal costs, risks, and effective influence
Contestability	Capacity to challenge and reopen practical arrangements	Correction, alternative evidence, dissent, appeal, review, reframing, reopening	Contestability requires usable pathways, protection, response conditions, and consequences for justified challenge

ters, but so do duration, reversibility, dependence, voluntariness, substitutability, distribution, and recovery capacity. A modest persistent burden can matter differently from a large transient burden. A reversible inconvenience differs from a loss that closes future options. A benefit that can be declined differs from one whose receipt creates dependency. These dimensions can be recorded without reducing them to one scalar measure.

Definition 10.302 (Affectedness profile). An *affectedness profile* is a stage- and horizon-specific account of the kinds, magnitudes, durations, reversibility conditions, dependencies, option changes, and recovery capacities through which a

subject-position is exposed to the consequences of praxis.

Affected subjects can be difficult to identify prospectively. Some consequences emerge only after implementation. Some propagate through relations that were initially outside the practical boundary. Some affect subjects who are institutionally unregistered or whose experiences are weakly represented by available categories. Some concern future subjects who cannot presently articulate claims. The practical task is therefore partly anticipatory. Problem formation, scenario analysis, local knowledge, historical reconstruction, monitoring, and revisable boundary setting can all contribute to identifying affected positions before and after commitment.

Affectedness can also be relationally asymmetric. An intervention can improve the action space of one position while narrowing another's. A procedure can reduce aggregate risk while concentrating residual risk among actors with weaker recovery capacity. A technological system can create convenience for users while increasing monitoring or maintenance burdens elsewhere. Such cases connect affectedness to the distributional analysis developed in Sections 10.10 and 10.11.

The category of affected subject has an epistemic function as well. Affected positions can possess situated knowledge unavailable to designers, decision-makers, or evaluators. They can encounter implementation details, cumulative burdens, practical frictions, or emergent consequences before those become visible in formal measurement. This knowledge should be assessed for its local scope and evidential character, while its situated origin can itself be informative about how consequences are distributed.

Proposition 10.303 (Affectedness and practical standing). *Where a practical trajectory materially alters a subject-position's burdens, capabilities, dependencies, risks, or future options, that affectedness provides a reason to include the position within the practical analysis and to consider appropriate pathways for knowledge, voice, protection, participation, representation, or review.*

Practical standing can vary with the question being addressed. A subject bearing direct irreversible risk can have strong grounds for participation in risk assessment and protective design. A subject with minor indirect exposure may have a different relation to implementation details. A future affected population may require representation through institutions, guardianship, scenario analysis, or preserved option space because direct participation is unavailable. The relevant architecture should therefore connect forms of affectedness to suitable forms of inclusion rather than assuming one identical participatory role for every affected subject.

10.12.2 Stakeholders

Affectedness identifies one relation to praxis. Application-dominant settings usually contain additional actors whose relevance arises through authority, responsibility, knowledge, resources, implementation, maintenance, dependence, or capacity to alter outcomes. The stakeholder category is useful for mapping this wider field, provided that it remains analytically differentiated.

Definition 10.304 (Practical stakeholder). *A practical stakeholder is an actor, collective, institution, or organized position with a consequential relation to a practical process through affectedness, authority, responsibility, knowledge, capability, resource contribution, implementation, maintenance, dependence, representation, monitoring, evaluation, or another role that can materially shape or be shaped by the praxis.*

Stakeholder status is therefore relational rather than honorary. An actor becomes practically relevant through a specified connection to the process. The connection should be named. One stakeholder may be a directly affected subject. Another may be responsible for implementation. A third may possess specialized knowledge. A fourth may finance or maintain infrastructure. A fifth may represent absent or dispersed subjects. Mapping these relations prevents the word *stakeholder* from flattening heterogeneous positions into a single generic category.

A stakeholder map also benefits from distinguishing interests from responsibilities. Some actors have strong interests in the outcome while possessing limited responsibility for the process. Others bear formal responsibilities even when their own interests are modest. Some actors possess knowledge without decision authority. Some can block action without bearing its principal consequences. These configurations matter because participation design should respond to the practical relation at issue.

Definition 10.305 (Stakeholder-role profile). A *stakeholder-role profile* records the relevant actor's affectedness, authority, knowledge, capability, resource relation, responsibility, implementation role, dependence, representational function, monitoring function, and capacity to alter or contest the practical process.

Stakeholder relations can change as praxis develops. An organization that begins as a technical adviser can become an implementer. An affected community can develop collective capacity and become a co-decision body. A supplier can become infrastructurally indispensable. An evaluator can acquire agenda-setting power when future funding depends on its assessment. Stakeholder analysis should therefore be updated at important transition points rather than treated as a one-time inventory.

The category also requires boundary discipline. A practical process can generate a very wide network of indirect interests. Expanding the stakeholder list without distinguishing relevance can make participation unworkable and obscure highly affected positions. A useful approach is to specify the relation, stage, and issue for which a stakeholder is relevant. This can support differentiated forms of participation: some actors may require decision rights, others technical consultation, others monitoring access, others protected voice, and others representation.

Definition 10.306 (Stakeholder topology). A *stakeholder topology* is a relational map of the actors and positions connected to a practical process, the kinds of connection among them, the stages at which those connections become consequential, and the pathways through which influence, burden, information, responsibility, or dependency can propagate.

The topology perspective also reveals missing positions. If implementation relies on unpaid maintenance, informal coordination, local mediation, or household adaptation, the relevant actors may be practically central even when absent from formal governance charts. Conversely, an institution can appear prominent in organizational documentation while having limited influence over the practical stage under analysis. Mapping relations rather than titles improves the accuracy of participation design.

Caution 10.307 (Stakeholder equivalence). Stakeholder status identifies a consequential relation to praxis. It does not by itself establish identical standing, authority, burden, expertise, responsibility, or claim strength across heterogeneous stakeholders. These dimensions should remain separately represented.

This caution is important for later justice analysis. A process that gives each stake-

holder the same procedural unit of influence can still reproduce substantial asymmetry if affectedness, risk, dependence, responsibility, or participation cost differ sharply. The stakeholder concept supports mapping; normative weighting requires additional argument.

10.12.3 Participation

Participation concerns practical entry into the process through which a situation is interpreted and acted upon. Because Section 10.11 distributed power across many loci, participation should be analyzed across corresponding stages. Actors can participate in problem recognition, evidence formation, interpretation, end specification, option generation, decision, implementation, monitoring, evaluation, and revision. These forms differ in their practical effects.

Definition 10.308 (Practical participation). *Practical participation* is a situated relation through which an actor or represented position enters one or more stages of application-dominant praxis with a recognized pathway to contribute information, interpretation, values, proposals, decisions, implementation, monitoring, evaluation, contestation, or revision.

Participation therefore has several dimensions. *Access* concerns whether entry is possible. *Contribution* concerns what participants can provide. *Uptake* concerns whether contributions enter the practical process. *Influence* concerns whether they can alter problem framing, ends, options, decisions, implementation, or review. *Protection* concerns whether participation can occur without disproportionate retaliation or exposure. *Continuity* concerns whether participation persists through relevant stages rather than ending after a single consultation event.

Definition 10.309 (Participation pathway). A *participation pathway* is the sequence of access points, contribution channels, uptake procedures, influence opportunities, feedback mechanisms, and review rights through which an actor or represented position can enter and remain connected to a practical process.

Participation pathways can be narrow or broad. A public comment period creates an access and expression pathway. A co-design process can extend participation into option generation. A delegated committee can allocate decision rights. Community monitoring can extend participation into implementation and evaluation. Appeal or reopening procedures can preserve participation after initial closure. These differences should be specified because the same label of participation can describe very different practical relations.

Participation can improve praxis in several ways. It can reveal affected positions omitted by the initial problem formulation. It can contribute situated knowledge. It can identify implementation constraints and latent actions. It can expose value conflicts. It can generate trust, shared vocabulary, and coordination capacity. It can also distribute learning across actors so that later adaptation becomes easier. These are possible practical functions whose relevance depends on context; participation does not guarantee them automatically.

Participation also has costs and risks. Meetings consume time. Repeated consultation can impose burdens on actors with limited resources. Disclosure can expose sensitive information or create interpersonal risk. Participation can create expectations that institutions lack capacity to meet. Highly technical processes can shift interpretive labor toward participants who already face burdens. These effects belong inside

the intervention footprint rather than being treated as external procedural details.

Definition 10.310 (Participation-stage profile). A *participation-stage profile* records which actors or represented positions can participate at each practical stage, the form of participation available, the contribution expected, the decision or review rights attached to it, and the principal costs or risks of participation.

Stage profiles help identify a common structural problem: participation can be broad during diagnosis and narrow during commitment, or narrow during design and broad only during implementation. Such arrangements can be appropriate when responsibilities differ, but their structure should remain visible. A process that invites experience after the decisive options have already been fixed provides a different form of agency from one that permits participation in problem and option formation.

Participation should also be proportionate to the practical issue. Some technical operations require specialized competence. Some emergency stages require rapid coordination. Some long-horizon commitments benefit from broader deliberation. Differentiated participation can therefore coexist with strong inclusion when the reasons for differentiated roles, the boundaries of delegated authority, and the pathways for challenge remain explicit.

Proposition 10.311 (Stage-specific participation). *The practical significance of participation depends partly on the stage at which participation occurs, the objects participants can influence, the burdens they bear, and the pathways through which their contributions can alter later praxis.*

10.12.4 Representation

Direct participation is frequently limited by scale, distance, time, expertise, disability, risk, organizational complexity, future affectedness, or the dispersed character of a population. Representation creates a practical relation through which one actor or institution carries the claims, interests, knowledge, values, or authority of positions that do not participate directly at every stage.

Definition 10.312 (Practical representation). *Practical representation* is a recognized relation through which an actor, collective, or institution is authorized, mandated, selected, entrusted, or otherwise positioned to articulate claims, exercise specified functions, or participate in consequential praxis on behalf of other subjects or positions.

Representation can take several forms. It can be electoral, delegated, professional, fiduciary, organizational, statistical, legal, customary, or emergent from collective practice. These forms create different mandates and accountability structures. A technical representative may be authorized to interpret evidence without authority to determine values. A legal guardian can possess decision responsibilities for an absent subject. A community representative can carry locally developed priorities into a larger institutional process. An indicator or aggregate can also function representationally in a different sense by standing for a population within decision systems, although such symbolic representation should be distinguished from agency-bearing representation.

The practical quality of representation depends partly on how the representational relation is maintained. A representative can possess a clear mandate, periodic feedback, accessible communication, and review. Another can remain distant from represented positions after selection. Representation can also become difficult where

represented subjects are internally heterogeneous or where the consequences of action differ across subgroups.

Definition 10.313 (Representation chain). A *representation chain* is the sequence of relations through which claims, knowledge, preferences, values, authority, or responsibility are translated from represented positions through one or more representatives into a practical process and back through feedback, reporting, review, or accountability.

Long representation chains can support large-scale coordination while increasing the possibility of translation loss. Each step can aggregate, simplify, reinterpret, prioritize, or delay information. The relevant issue is not the mere length of the chain. The important questions concern what is preserved, what is transformed, what feedback remains possible, and whether represented positions can challenge a representation that becomes materially inaccurate or unresponsive.

Representation also has a temporal dimension. The represented population can change. New affected groups can emerge. A mandate appropriate during emergency stabilization can become insufficient for long-term structural decisions. Representatives themselves can acquire knowledge, resources, and institutional position that alter their relation to the people they represent. Representation should therefore be revisable as the practical situation changes.

Definition 10.314 (Representational distance). *Representational distance* is the practical separation between represented positions and the actor or institution acting on their behalf, assessed through access, feedback, information flow, mandate clarity, substitutability, review, and capacity to correct divergence.

Representational distance can be small even across large geographic scale where feedback and accountability are strong. It can be large within the same organization where represented positions have little access to those speaking for them. This concept therefore remains relational rather than spatial.

Some affected subjects cannot authorize representatives directly. Future subjects, very young children, some incapacitated persons, non-human living systems, or diffuse ecological relations can enter praxis only through forms of guardianship, trusteeship, expertise, legal standing, scenario analysis, or institutionalized duties. Such representation carries a special burden of justification because direct feedback can be limited or unavailable. Preserving future options and making assumptions explicit become especially important under these conditions.

Proposition 10.315 (Representation and feedback). *Where direct participation is limited, representation can extend practical inclusion when mandate, translation, feedback, accountability, and revision pathways remain sufficiently connected to the positions and consequences being represented.*

10.12.5 Voice

Participation and representation create channels of entry. Voice concerns the practical capacity to articulate experience, knowledge, judgment, objection, proposal, or dissent in a form that can enter the relevant process and encounter a pathway of reception. Voice therefore links expression to practical uptake without requiring that every expressed claim determine the final decision.

Definition 10.316 (Practical voice). *Practical voice* is the situated capacity of an actor

or represented position to articulate a practically relevant experience, claim, interpretation, value, warning, objection, proposal, or dissent through a channel that can be received, considered, and responded to within consequential praxis.

Voice has at least four components. *Expression* concerns the ability to formulate a contribution. *Transmission* concerns access to a channel through which it can travel. *Reception* concerns whether relevant actors or institutions can hear, read, interpret, or otherwise register it. *Response* concerns whether the process provides a way to acknowledge, incorporate, reject with reasons, investigate, or reopen the matter. Weakness at any point can reduce effective voice.

Definition 10.317 (Voice pathway). A *voice pathway* is the practical sequence through which an expression is produced, transmitted, translated where necessary, received by relevant actors, entered into deliberation or review, and connected to a response or revision mechanism.

Voice can be constrained by language, technical vocabulary, procedural rules, time limits, social status, fear of retaliation, accessibility, data requirements, or cultural expectations about legitimate expression. Some knowledge is readily translated into institutional categories. Other knowledge appears as narrative, embodied experience, local practice, informal observation, or a pattern that has not yet acquired a recognized indicator. A participation architecture should therefore consider translation capacity without requiring every form of knowledge to become identical in format.

Voice also differs from influence. An actor can speak extensively while having little capacity to alter the process. Conversely, a brief intervention can have substantial influence when it enters a high-leverage decision point. Recording voice separately from decision power prevents symbolic inclusion from being confused with practical agency.

Definition 10.318 (Effective voice). *Effective voice* is practical voice supported by sufficient transmission, intelligibility, protection, institutional reception, and response capacity for the contribution to have a plausible pathway to affect interpretation, action, review, or the recorded reasons for maintaining the current course.

Effective voice also requires room for disagreement. A process organized only around consensus can suppress information carried by minority positions, dissent, or outlying experience. Dissent can reveal hidden risk, boundary errors, implementation failure, or value conflict. Its practical role depends on evidential quality and relevance, while the architecture should preserve a path through which disagreement can be expressed and examined.

Voice can be collective. Petitions, associations, professional bodies, community organizations, worker groups, user groups, and other collectives can aggregate dispersed experiences into more legible forms. Collective voice can reduce participation cost and increase bargaining capacity, while aggregation can also suppress internal variation. The relation between collective expression and internal diversity therefore remains analytically important.

Proposition 10.319 (Voice and practical uptake). A *participation architecture strengthens effective voice when relevant expressions can travel through protected and intelligible channels into practical reception, reasoned response, monitoring, or revision rather than terminating at the point of expression.*

10.12.6 Distributed Decision-Making

Section 10.11 distinguished formal decision power from implementation, knowledge, and other loci of power. Distributed decision-making develops this insight institutionally. Decision authority can be allocated across actors, stages, domains, or scales so that different positions decide different practical objects under specified conditions.

Definition 10.320 (Distributed decision-making). *Distributed decision-making* is an arrangement in which authority to authorize, condition, implement, revise, veto, escalate, or review practical commitments is allocated across multiple actors, collectives, institutions, stages, domains, or scales according to specified competences and relations.

Distribution can occur by function. One body defines technical standards while another authorizes resource use. It can occur by stage. A local unit can authorize reversible pilots while a broader institution decides durable expansion. It can occur by scale. Local actors can adapt implementation within system-wide safety constraints. It can occur by issue. Affected subjects can possess decision rights over particular forms of data use while institutions retain authority over other operational questions.

Distributed decision-making can support local knowledge, resilience, redundancy, specialization, and adaptation. It can also reduce dependence on a single decision center. Yet distribution can create coordination problems when authority boundaries are unclear, when decisions interact across scales, or when responsibility becomes difficult to trace. The design therefore requires explicit interfaces.

Definition 10.321 (Decision-rights architecture). A *decision-rights architecture* specifies which positions can propose, authorize, condition, veto, implement, review, reopen, or escalate which practical commitments, at which stages and scales, and under which triggering conditions.

Interfaces among decision centers require mechanisms for conflict, inconsistency, and temporal coordination. One unit may need rapid action while another retains review authority. Local adaptation can conflict with system-wide interoperability. A safety body can impose constraints on an operational body. These interactions can be managed through precedence rules, escalation pathways, joint review, time-limited authority, nested mandates, or shared thresholds.

Definition 10.322 (Decision interface). A *decision interface* is the set of rules, communication pathways, escalation procedures, precedence relations, and review conditions through which two or more decision centers coordinate interacting commitments.

Distributed decision-making also has a generative effect on capability. Giving local actors meaningful authority can generate learning and institutional competence. Repeated central override can weaken local capacity. Conversely, highly fragmented authority can prevent actors from developing experience with system-wide consequence. The distribution of decision rights therefore shapes future agency as well as present decisions.

A distributed architecture should also remain connected to affectedness. Decision rights can be allocated partly according to consequence exposure, knowledge, responsibility, competence, or scale. These criteria can point toward different distributions. The practical design question concerns how they are combined for the issue at hand while preserving transparency and revision.

Proposition 10.323 (Distribution and coordination). *Distributed decision-making can expand practical agency when differentiated authority is matched by workable decision interfaces, traceable responsibilities, relevant knowledge, and mechanisms for coordination, escalation, and revision.*

10.12.7 Collective Agency

Distributed decision rights describe an institutional arrangement. Collective agency concerns a different phenomenon: the emergence of a coordinated capacity through which a plurality of actors can form, sustain, implement, and revise joint praxis. Collective agency is relevant when consequential action exceeds the capacity of any single participant and depends on organized relations among participants.

Definition 10.324 (Collective practical agency). *Collective practical agency* is the relationally generated capacity of a plurality of actors to form sufficiently shared practical orientations, coordinate differentiated roles, sustain consequential action through time, learn from consequences, and revise joint commitments through recognizable collective processes.

This definition treats collective agency as a capacity of organized relations. Shared identity can contribute to it, but shared identity is not required in every case. Actors with different interests can develop collective agency around a bounded practical task when coordination, role differentiation, communication, trust, rules, resources, and revision procedures are adequate to sustain joint action.

Collective agency has several constituent capacities. *Orientation capacity* supports formation of a sufficiently shared practical direction. *Coordination capacity* aligns differentiated contributions. *Execution capacity* mobilizes resources and maintains action. *Memory capacity* preserves reasons, commitments, consequences, and prior learning. *Reflection capacity* permits the collective to interpret feedback. *Revision capacity* allows ends, roles, or procedures to change when conditions warrant.

Definition 10.325 (Collective-agency profile). *A collective-agency profile* records a collective's capacities for orientation, coordination, execution, memory, reflection, conflict handling, representation, and revision across the stages relevant to a practical process.

Collective agency can be uneven. A group can coordinate implementation effectively while lacking a reliable process for revising ends. An institution can preserve memory while providing weak voice to front-line participants. A coalition can mobilize quickly and then struggle with maintenance. A distributed network can generate ideas rapidly while lacking authority to commit resources. Profiling these dimensions avoids treating the collective as a unitary actor with a single level of capability.

Collective agency also changes through action. Successful coordination can generate trust, routines, shared vocabulary, and institutional memory. Failure can expose interface problems and prompt redesign. Repeated exclusion can fragment collective capacity. Concentrated authority can increase short-run speed while reducing distributed learning. Participatory processes can generate new organizations that later become durable actors. Collective agency is therefore both a condition and a possible outcome of application-dominant praxis.

Definition 10.326 (Agency-generating participation). *Agency-generating participation* is participation that materially increases the later capacity of actors or collectives

to understand, coordinate, decide, act, monitor, contest, or revise within the relevant practical field.

This concept connects participation to the generative orientation of GR. A process can be evaluated partly by what capacities it leaves behind. An intervention that solves an immediate coordination problem while making future collective action more dependent on a narrow center produces a different generative trajectory from one that builds distributed competence. The comparison remains context-sensitive because some situations require concentrated expertise or emergency coordination.

Collective agency can also contain internal asymmetry. A collective label can obscure unequal voice, agenda control, labor, or risk. Analysts should therefore preserve both levels: the collective's capacity to act externally and the internal relations through which that capacity is produced. This prepares the next subsection on unequal participation.

Proposition 10.327 (Collective agency as generated capacity). *Where coordinated praxis creates durable capabilities for joint orientation, action, learning, memory, and revision, participation can generate collective agency that changes the later practical possibilities of the participating positions.*

10.12.8 Unequal Participation

Participation opportunities are rarely costless or evenly usable. Actors can differ in available time, mobility, language, literacy, technical expertise, digital access, organizational support, safety, social recognition, confidence, care responsibilities, financial reserves, legal status, and familiarity with institutional procedure. These differences can shape who participates, how often, with what form of evidence, and with what practical influence.

Definition 10.328 (Participation inequality). *Participation inequality* is a consequential difference among positions in their practical capacity to access, sustain, influence, benefit from, or safely withdraw from participatory processes relevant to application-dominant praxis.

Participation inequality can appear even under formally identical access conditions. An evening meeting can be open to everyone while remaining difficult for people with care duties or inflexible work. A technical consultation can accept comments from all actors while privileging those able to produce institutionally legible documentation. A digital process can reduce travel cost while excluding actors with weak connectivity or accessibility. Equal formal invitation is therefore one component of participation architecture, while effective participation depends on a wider capability structure.

Definition 10.329 (Participation-burden profile). *A participation-burden profile* records the time, financial cost, cognitive demand, translation requirement, disclosure burden, travel, accessibility need, safety exposure, emotional labor, opportunity cost, and procedural effort required for a position to enter and remain in a participatory process.

Burden profiles can reveal cumulative inequalities. A single meeting may impose a small cost, while repeated consultations over months become difficult for participants without institutional support. Actors whose participation is professionally funded can sustain engagement more easily than actors contributing unpaid time. The result-

ing asymmetry can gradually shift agenda-setting and institutional memory toward the more persistent participants.

Recognition also matters. Participants can enter the same forum while their contributions receive different credibility, interpretive generosity, or evidential status. Some forms of expertise are institutionally certified. Other forms arise from lived experience, local practice, maintenance work, or informal observation. A plural methodology can evaluate different forms of contribution according to their evidential function while preserving the possibility that recognition itself is unevenly distributed.

Definition 10.330 (Participation conversion). *Participation conversion* is the process through which formal access to a participatory setting becomes effective capacity to contribute, receive uptake, influence relevant practical objects, and remain connected to feedback and revision.

Participation conversion depends on enabling conditions. Translation, accessible formats, compensation, childcare, protected time, independent facilitation, technical support, confidentiality, transportation, asynchronous participation, capacity building, and procedural education can alter the effective action space of participants. The appropriate supports depend on the actual burden structure and should be treated as part of practical design.

Unequal participation can also be generated by the intervention itself. An institutional reform can create new participation channels for some actors while increasing procedural complexity for others. A data system can amplify the voice of groups with strong reporting capacity. A decentralization process can expand local decision rights where local institutions are strong while leaving other areas with weak practical capacity. Monitoring should therefore examine the distributional effects of participation architecture over time.

The aim of participation design is not necessarily identical influence in every matter. Expertise, responsibility, affectedness, legal authority, and implementation role can justify differentiated functions. The relevant analytical requirement is to make those differences explicit, examine how they are justified, identify the burdens they produce, and preserve pathways for challenge when the differentiation becomes practically harmful or unresponsive.

Proposition 10.331 (Formal access and effective participation). *Formal access becomes effective participation only through conversion conditions that make contribution, uptake, influence, continuity, and safe withdrawal practically reachable for the relevant positions.*

10.12.9 Contestability

Application-dominant praxis requires provisional closure because action cannot remain indefinitely suspended. Sections 10.4, 10.5, and 10.8 nevertheless established that problem formulations, judgments, and decisions remain revisable. Contestability provides an institutional and relational capacity through which such revisability can become practically usable after power, authority, and routines have begun to stabilize a course of action.

Definition 10.332 (Practical contestability). *Practical contestability* is the situated capacity to question, challenge, supplement, appeal, reopen, or seek review of a prob-

lem formulation, evidential claim, practical end, decision, implementation practice, measurement regime, evaluation, representational relation, or other consequential element of praxis through a recognized pathway capable of producing response or revision.

Contestability differs from permanent veto. A contestable arrangement can continue operating while preserving channels through which challenges are heard, reasons are examined, and material errors or harms can trigger review. It also differs from informal complaint alone. Effective contestability requires a path from challenge to a body or process capable of responding.

Definition 10.333 (Contestability pathway). A *contestability pathway* is the sequence through which a challenge can be raised, protected, received, documented, assessed, answered, escalated where necessary, and connected to correction, compensation, suspension, redesign, or reopening.

Contestability can operate at multiple loci. Problem-definition contestability permits alternative framing and boundary revision. Evidential contestability permits supplementary data, methodological challenge, or reanalysis. Normative contestability permits disagreement about ends and burden distribution. Decision contestability permits appeal or review of commitments. Implementation contestability addresses local practices. Measurement contestability, introduced in Section 10.11, permits challenge to categories and indicators. Evaluation contestability permits alternative interpretations of success or harm. Representational contestability permits represented positions to challenge those acting on their behalf.

The usability of these pathways depends on several conditions. Challengers need information about the decision and the reasons supporting it. They need access to records or evidence adequate to formulate a challenge. They may need protection from retaliation. Review needs sufficient independence from the original decision where conflicts of interest are substantial. Time matters because a review completed after irreversible consequences can have limited practical value. Remedies also matter; a process that can acknowledge an error without changing anything has weaker practical contestability than one connected to correction or compensation.

Definition 10.334 (Contestability architecture). A *contestability architecture* is the organized set of transparency, access, protection, review, escalation, timing, remedy, and reopening arrangements through which consequential praxis remains practically challengeable after provisional commitment.

Contestability can support learning. A challenge can reveal an omitted affected position, an unreliable measurement, a changed implementation condition, an unanticipated interaction, or a value conflict that earlier stages did not adequately represent. When records preserve the challenge and the response, contestation becomes part of institutional memory. Recurrent challenges can indicate that the problem lies in the underlying architecture rather than in isolated decisions.

Contestability also has costs. Endless reopening can impede coordination, create uncertainty, or allow strategically powerful actors to delay protective action. Practical design therefore requires thresholds, standing rules, time windows, escalation levels, or differentiated review procedures. These constraints should preserve meaningful access while preventing the review system from becoming a general mechanism of paralysis. The appropriate structure depends on urgency, irreversibility, burden, and the availability of corrective action.

Definition 10.335 (Protected dissent). *Protected dissent* is an institutionalized condition under which participants can raise materially relevant disagreement, warnings, or objections without disproportionate retaliation and with access to a documented pathway of practical response.

Protected dissent is especially important where authority is concentrated, information is asymmetric, or implementation occurs far from formal decision centers. Front-line actors and affected subjects can observe consequences before central institutions do. Preserving a channel for early warning can therefore improve both epistemic quality and practical safety.

Proposition 10.336 (Contestability and revisable closure). *Practical closure remains more effectively revisable when participants and affected positions retain usable pathways to challenge consequential assumptions, decisions, implementations, measurements, evaluations, and representations after commitment.*

Participation and distributed agency therefore concern more than presence within a deliberative forum. They concern how affectedness is identified, how stakeholders are differentiated, how participation enters successive stages, how absent positions are represented, how voice reaches practical uptake, how decision rights are distributed, how collective capacity is generated, how participation burdens are allocated, and how established arrangements remain contestable. These relations shape both present action and the future capacities through which actors can participate in later praxis.

The architecture developed here also creates a problem of responsibility. Distributed agency can improve knowledge, coordination, and legitimacy while making causal and normative responsibility more difficult to locate. A decision can be jointly authorized, locally implemented, technically advised, institutionally funded, externally evaluated, and later revised by actors who occupy different positions in the process. Participation can also create responsibilities of representation, response, maintenance, and follow-through. Section 10.13 therefore turns to responsibility and accountability, distinguishing responsibility for decision, action, inaction, uncertainty, distributed contribution, institutional structure, traceability, and long-horizon consequence.

10.13 Responsibility and Accountability

Sections 10.11 and 10.12 showed that application-dominant praxis is distributed across multiple loci of power and multiple forms of participation. Problem definition, end specification, decision, implementation, measurement, evaluation, representation, contestation, and exit can be carried by different actors and institutions. This distribution creates a corresponding question of responsibility. The present section examines responsibility across the full practical sequence, extending its analysis beyond a single moment of choice, a single causal actor, or retrospective blame. Its objective is to distinguish responsibility for decision, action, inaction, uncertainty, distributed contribution, institutional structure, accountability, traceability, and long-horizon consequence. The discussion remains domain-general and relational. Responsibility is treated as a structured connection among practical role, authority, capacity, knowledge, contribution, undertaking, consequence, and the possibility of response.

Responsibility has both prospective and retrospective dimensions. Prospectively, it concerns what an actor or institution is expected to attend to, preserve, decide, perform, monitor, disclose, repair, or revise before and during consequential action. Retrospectively, it concerns how decisions, omissions, implementations, institutional arrangements, and consequences can be reconstructed and answered for after they occur. These dimensions can overlap while remaining analytically distinct. A practical architecture that concentrates only on retrospective attribution can neglect prevention, maintenance, and learning. An architecture that emphasizes only prospective duties can leave weak pathways for explanation, correction, or remedy after harmful consequence.

Definition 10.337 (Practical responsibility). *Practical responsibility* is a situated relation through which an actor, collective, or institution bears a warranted obligation to attend to, answer for, sustain, revise, prevent, repair, or otherwise respond to a practical object because of its role, authority, capacity, undertaking, knowledge, contribution, or relation to the relevant consequences.

The definition leaves open several grounds of responsibility because application-dominant praxis rarely contains only one. Decision authority can create responsibility even where implementation is delegated. Technical contribution can create responsibility for the reliability of a component while leaving broader programme responsibility with other positions. Possession of unique knowledge can create a responsibility to communicate a warning even when the knowledgeable actor lacks decision authority. Institutional mandate can create a duty of maintenance that persists across personnel changes. Affectedness primarily identifies exposure and standing; affected actors can acquire further responsibilities through later participation, representation, or collective action.

Responsibility should also be distinguished from several neighboring concepts. Causal contribution can support responsibility while remaining insufficient by itself where agency, knowledge, role, or capacity are absent. Formal authority can support responsibility while leaving operational contribution elsewhere. Accountability concerns the organized conditions under which responsibility is made answerable and practically reviewable. Liability is a more specific legal or institutional status and is outside the general conceptual burden of this section. Blame is an evaluative response to some forms of responsibility failure, whereas practical responsibility also includes ordinary duties of care, documentation, maintenance, monitoring, learning, and repair.

Table 10.13 separates responsibility according to the practical object to which it attaches. The same actor can occupy several rows, and several actors can share one row through differentiated roles. The purpose of the separation is analytical: it distinguishes practical objects while allowing roles to overlap. It helps identify where practical duties arise, where responsibility can become diffuse, and which records or institutional interfaces are required for later answerability.

Definition 10.338 (Responsibility profile). A *responsibility profile* is a stage-, role-, and object-specific account of the prospective and retrospective responsibilities borne by relevant actors, collectives, and institutions across problem formation, decision, action, non-action, monitoring, evaluation, repair, and revision.

A responsibility profile should preserve both the grounds and the limits of each responsibility. Unbounded expansion can make responsibility analytically empty and practically unusable. Excessively narrow attribution can leave interfaces, cumulative

Table 10.13: Principal dimensions of responsibility and accountability in application-dominant praxis.

Dimension	Primary practical object	Characteristic basis	Characteristic requirement
Decision	Authorized commitment	Decision right, veto, delegation, ratification	Reasons, threshold justification, conflict disclosure, reopening conditions
Action	Implementation and maintenance	Operational control, expertise, execution capacity, undertaking	Competent execution, adaptation records, monitoring, repair
Inaction	Omission, delay, non-response	Capacity, standing, knowledge, opportunity, assigned duty	Justification of forbearance, escalation, preservation of alternatives
Uncertainty	Residual epistemic incompleteness	Knowledge position, risk control, decision authority	Uncertainty characterization, calibration, monitoring, updating
Distributed responsibility	Multi-actor contribution	Complementary roles, causal chains, shared authority, interdependence	Role mapping, interface duties, gap prevention, coordinated response
Institutional responsibility	Durable organized praxis	Mandate, rules, routines, infrastructure, memory, resource control	Continuity, governance, institutional learning, correction across turnover
Accountability	Answerability and review	Responsibility relation plus authorized forum or process	Explanation, scrutiny, response, remedy, revision, learning
Traceability	Reconstruction of practical provenance	Records, version history, role assignment, evidence and decision provenance	Recoverable sequence from grounds to commitment, action, consequence, and revision
Long horizon	Delayed and persistent consequence	Continuing influence, maintenance burden, path creation, inherited commitment	Stewardship, handoff, periodic review, preservation of future response capacity

effects, or revision without a capable responsibility-bearing position even when consequential processes are jointly produced. The task is therefore to reconstruct the architecture through which responsibility is generated, divided, transferred, retained, and sometimes lost.

10.13.1 Responsibility for Decision

Decision responsibility concerns the practical obligations attached to converting a set of possibilities into an authorized commitment. Section 10.8 treated decision as provisional commitment under incomplete knowledge, while Section 10.11 distinguished decision power from other loci of power. Responsibility for decision asks what follows once a position possesses the authority or effective capacity to authorize, block, condition, ratify, or reopen such a commitment.

Definition 10.339 (Decision responsibility). *Decision responsibility* is the obligation attached to a decision-bearing position to ensure that a consequential commitment is formed through appropriately warranted reasons, procedures, thresholds, disclosures, and revision conditions relative to the practical situation.

Decision responsibility begins before the formal moment of authorization. A decision-holder can be responsible for whether relevant evidence was sought, whether materially affected positions were recognized, whether conflicts of interest were disclosed, whether uncertainty was characterized, whether alternatives were considered, and whether the decision threshold matched the consequence structure. It can continue after authorization through duties to preserve records, receive monitoring information, and reopen the commitment when pre-specified conditions are met.

Delegation complicates this architecture. A principal can delegate analysis, recommendation, implementation, or even bounded decision authority while retaining responsibility for the design and oversight of the delegation. The delegate can simultaneously bear responsibility for competent exercise of the assigned role. Transfer of a task therefore redistributes responsibility according to the retained and delegated practical objects.

Definition 10.340 (Responsibility-retention condition). *A responsibility-retention condition is a feature of a practical arrangement under which an actor or institution remains responsible for a relevant object after delegating, contracting, automating, or otherwise transferring part of the activity through which that object is handled.*

Responsibility-retention conditions are especially important where the delegating actor selects the delegate, defines the mandate, controls the resources, determines the evaluation criteria, or retains the capacity to intervene. An institution that commissions an automated system, for example, can delegate computation while retaining responsibility for procurement, deployment conditions, monitoring, escalation, and the decision to rely on the output. The general point applies across technologies and organizational forms. Delegation changes the responsibility architecture while retained control, selection, or oversight can preserve responsibilities of the delegating position.

Decision responsibility also includes dissent. Collective bodies can reach an authorized decision while containing materially relevant disagreement. A responsibility architecture benefits from preserving whether dissent concerned evidence, values, procedure, risk, implementation, or affected positions. Such records protect institutional memory and can become important when later consequences activate reopening conditions.

Definition 10.341 (Decision responsibility record). *A decision responsibility record preserves the responsible decision positions, delegated roles, principal reasons, material uncertainties, dissent, conflicts of interest, threshold conditions, monitoring requirements, and reopening conditions associated with a practical commitment.*

The record supports later accountability under conditions of inevitably limited foresight. It allows subsequent reviewers to distinguish a decision that was carefully warranted under the knowledge available at the time from one whose deficiencies were already visible but omitted, suppressed, or left unexamined.

Proposition 10.342 (Decision responsibility across commitment). *Where a position possesses practical authority to authorize or block consequential commitment, its responsibility extends to the warrant, procedure, disclosure, and revision architecture through which that authority is exercised.*

10.13.2 Responsibility for Action

Responsibility for action concerns the translation of authorized orientation into concrete intervention. Section 10.11 distinguished decision power from action power because execution requires resources, access, expertise, coordination, and local discretion. The corresponding responsibility can therefore be distributed differently from decision responsibility.

Definition 10.343 (Action responsibility). *Action responsibility* is the obligation attached to a position that plans, executes, coordinates, maintains, or materially controls an intervention to perform its role competently, preserve relevant constraints, monitor material consequences, and respond to implementation-relevant change.

Action responsibility contains both fidelity and adaptation. Implementers can be responsible for respecting the authorized end, safeguards, limits, and reporting requirements. They can also be responsible for adapting when local conditions materially diverge from the assumptions under which the intervention was designed. These two responsibilities can conflict. Mechanical fidelity can be harmful where conditions have changed, while unconstrained adaptation can exceed the legitimate scope of implementation discretion.

A useful practical architecture therefore specifies an adaptation envelope: which features can be adjusted locally, which require consultation, which require new authorization, and which trigger suspension. This makes implementation discretion visible and connects it to escalation pathways.

Definition 10.344 (Implementation-responsibility envelope). An *implementation-responsibility envelope* specifies the range within which implementers may adapt an intervention, the constraints they must preserve, the conditions requiring escalation, and the records needed to explain significant deviations from the authorized plan.

Action responsibility also includes maintenance. Many interventions create infrastructures, dependencies, recurring services, monitoring obligations, or repair burdens that extend beyond initial deployment. A project can therefore be responsibly initiated and poorly sustained. Maintenance responsibility should be specified when action creates conditions whose functioning or safety depends on continuing support.

Repair is another component. When implementation produces avoidable error, localized harm, or unanticipated breakdown, responsibility can include correction, restoration, compensation, communication, or redesign. The appropriate response depends on the type of consequence and the actor's capacity to influence it. Repair responsibility therefore belongs to the practical architecture independently of whether a blame judgment is warranted.

Definition 10.345 (Action-responsibility chain). An *action-responsibility chain* maps the positions responsible for planning, execution, coordination, maintenance, monitoring, escalation, repair, and termination across the life of an intervention.

This chain is especially useful where implementation crosses organizational boundaries. Contractors, professional teams, local operators, funders, regulators, infrastructure providers, and affected communities can occupy different roles. The chain identifies interfaces at which responsibility can become ambiguous and allows those interfaces to be designed before failure occurs.

Proposition 10.346 (Responsibility through implementation). *Where consequential action depends on interpretation, adaptation, maintenance, and repair, responsibility*

follows the practical capacities exercised at those stages in addition to the responsibility attached to the original decision.

10.13.3 Responsibility for Inaction

Section 10.9 distinguished several forms of action and non-action, including forbearance, waiting, delay, refusal, withdrawal, and exit. Responsibility for inaction requires equal differentiation. The absence of intervention can arise from deliberate restraint, uncertainty, incapacity, lack of authority, fragmented coordination, exclusion, ignorance, or failure to recognize a problem. These pathways carry different responsibility structures.

Definition 10.347 (Inaction responsibility). *Inaction responsibility* is responsibility associated with a consequential omission, delay, refusal, withdrawal, or failure to respond where a position had a materially relevant combination of practical standing, capacity, knowledge, opportunity, and obligation to influence the evolving situation.

This formulation distinguishes consequential non-intervention from omissions attributable to a particular actor. Responsibility depends on the relation between the actor and the practical object. A position may lack authority, resources, knowledge, or reasonable opportunity to act. Another actor may possess those capacities but face legitimate reasons for forbearance. A third may deliberately withhold action despite a clear assigned duty. These cases should remain analytically distinct.

Definition 10.348 (Inaction-responsibility conditions). *Inaction-responsibility conditions* are the role, knowledge, capacity, opportunity, authority, consequence, and duty conditions relevant to determining whether a position bears responsibility for a consequential absence or withholding of action.

The conditions can vary by situation. Urgency can increase the practical significance of delay. High uncertainty can make restraint warranted while increasing the responsibility to gather information or preserve options. Fragmented authority can create a coordination problem in which several actors possess partial capacities while complete control is absent from the practical field. In such cases responsibility analysis should examine whether there was also responsibility to coordinate, escalate, communicate, or create a temporary joint response.

Waiting can carry responsibility for monitoring. Refusal can carry responsibility for communicating reasons and consequences where other actors depend on the refused contribution. Withdrawal can create handoff obligations where abrupt departure would transfer unmanaged burden to others. Exit can create residual responsibilities where the exiting actor retains control over information, infrastructure, or repair capacity needed by those who remain. These responsibilities are context-sensitive and should be stated through explicit role and dependency relations.

Inaction responsibility also includes the design of institutional default states. If a system requires active intervention before protection occurs, responsibility can be concentrated in those able to trigger action. If a protective measure remains in force until actively withdrawn, responsibility shifts toward those able to remove it. Defaults therefore shape the architecture of omission and should be treated as practical design choices.

Proposition 10.349 (Responsibility and consequential non-action). *Responsibility for non-action becomes practically relevant when a consequential trajectory intersects with*

a position that possessed a warranted relation of capacity, knowledge, standing, opportunity, or assigned duty to alter, monitor, escalate, or responsibly preserve that trajectory.

10.13.4 Responsibility under Uncertainty

Application-dominant praxis frequently requires commitment before uncertainty has been resolved. Section 10.8 treated incomplete knowledge as a condition for decision design, and Section 10.10 distinguished characterized risk from forms of uncertainty that remain structurally or evidentially open. Responsibility under uncertainty concerns the obligations that arise from this epistemic condition.

Definition 10.350 (Responsibility under uncertainty). *Responsibility under uncertainty* is the obligation to characterize materially relevant uncertainty, calibrate commitment to its consequence structure, preserve proportionate monitoring and revision capacity, and update practical orientation when the evidential situation materially changes.

The definition centers responsibility on epistemic handling under conditions where perfect prediction is unavailable. A decision-maker can act responsibly while some consequences remain unknown. Conversely, merely stating that uncertainty exists is insufficient where the uncertainty can be characterized, reduced, monitored, or bounded through practical design. Responsibility concerns the quality of uncertainty handling across characterization, calibration, communication, monitoring, and revision.

Several duties can follow from this principle. *Characterization responsibility* concerns identifying the important unknowns and distinguishing forms of uncertainty where possible. *Reduction responsibility* concerns gathering additional information where the expected value of learning is material and delay is acceptable. *Calibration responsibility* concerns matching scale, duration, reversibility, and exposure to the uncertainty profile. *Monitoring responsibility* concerns observing consequences capable of changing the decision. *Updating responsibility* concerns revising prior judgments when material evidence changes.

Definition 10.351 (Uncertainty-responsibility profile). An *uncertainty-responsibility profile* records which positions are responsible for identifying, reducing, communicating, monitoring, and responding to the principal residual uncertainties associated with a practical commitment.

Communication is especially important where those exposed to consequences differ from those controlling the decision. Affected positions can require information about uncertainty in order to consent, prepare, contest, or exercise exit. Uncertainty communication should therefore preserve the distinction between what is known, what is estimated, what remains contested, and what remains outside present characterization.

Uncertainty can also be distributed strategically. One actor may receive the benefits of early commitment while another bears the downside of uncertain consequences. A responsibility analysis should therefore ask who is authorized to create exposure, who can reduce or monitor the uncertainty, who bears the consequences if the uncertainty resolves adversely, and who possesses the capacity for recovery. These relations connect responsibility directly to the risk distribution described in Section 10.10.

Definition 10.352 (Uncertainty-burden allocation). *Uncertainty-burden allocation* is the distribution of exposure, information requirements, monitoring duties, adaptation costs, and recovery burdens generated by residual uncertainty across the positions involved in a practical process.

Responsible uncertainty management therefore has both epistemic and distributive dimensions. The former concerns the quality of the knowledge process; the latter concerns who bears the consequences of acting before the knowledge process is complete.

Proposition 10.353 (Responsibility under Epistemic Incompleteness). *Epistemic incompleteness reconfigures practical responsibility toward characterization, calibration, communication, monitoring, revision, and explicit allocation of uncertainty-related burdens.*

10.13.5 Distributed Responsibility

The distributed agency developed in Section 10.12 implies that responsibility can also be distributed. A practical outcome may depend on problem framing by one body, evidence generated by another, a decision authorized by a third, implementation by several organizations, and evaluation by still another. Responsibility analysis should preserve these differentiated contributions while retaining both collective organization and distinct positional roles.

Definition 10.354 (Distributed responsibility). *Distributed responsibility* is a responsibility structure in which several actors, collectives, or institutions bear differentiated, overlapping, complementary, or sequential obligations toward a shared practical object or consequence.

Distributed responsibility can take several forms. *Joint responsibility* arises where actors jointly authorize or perform a practical act. *Complementary responsibility* arises where different roles are each necessary to an overall process. *Sequential responsibility* arises along a chain in which one stage creates conditions for the next. *Overlapping responsibility* arises where several positions independently retain duties toward the same object, such as monitoring safety or protecting affected subjects.

Definition 10.355 (Responsibility topology). A *responsibility topology* maps practical objects to the actors, collectives, and institutions that bear decision, action, monitoring, communication, maintenance, repair, review, or revision responsibilities, together with the interfaces connecting those responsibilities.

The topology makes responsibility gaps visible. A process can contain competent actors at every stage while leaving an interface unowned. Data can be collected while responsibility for reviewing anomalies remains unassigned. An implementation team can detect problems while escalation authority or duty remains absent. A decision body can receive reports while the duty to reopen the decision remains unspecified. Responsibility gaps therefore frequently arise at interfaces among named roles.

Responsibility diffusion is a related phenomenon. When many actors contribute, each can perceive its own influence as small and defer to the presumed responsibility of others. This can weaken response even where the collective system possesses adequate capacity. Explicit role mapping, escalation rules, named interface owners, and joint review procedures can reduce such diffusion.

Definition 10.356 (Responsibility gap). A *responsibility gap* is a practically consequential object, interface, or transition for which the existing responsibility architecture fails to provide a sufficiently capable and answerable position for attention, response, escalation, or revision.

Distributed responsibility should also preserve proportionality. An actor who supplied a bounded technical component bears a responsibility profile different from the body that selected the system, defined its use, authorized deployment, and controlled monitoring. Narrow role descriptions still require scrutiny where foreseeable interface effects fell within the actor's practical capacity to address.

The relevant analytical question is therefore relational: which position controlled which object, possessed which knowledge, had which capacity, undertook which role, and retained which possibility of response? This reconstructs responsibility from the process and uses organizational title as one source of evidence about role and authority.

Proposition 10.357 (Distributed responsibility and interface ownership). *Where consequential praxis depends on multiple differentiated contributors, responsibility becomes more practically coherent when the interfaces among roles receive explicit ownership in addition to the responsibilities assigned within each role.*

10.13.6 Institutional Responsibility

Institutions stabilize mandates, roles, routines, records, infrastructures, resources, and decision procedures across changes in individual personnel. They can therefore bear forms of practical responsibility whose reconstruction requires more than aggregating the responsibilities of currently present individuals. Institutional responsibility concerns this durable organized capacity.

Definition 10.358 (Institutional responsibility). *Institutional responsibility* is the responsibility generated by an institution's mandate, organized capacities, rules, routines, resource control, infrastructures, memory, and continuing influence over a practical field.

Institutional responsibility can arise from what the institution is constituted to do, from capacities it has accumulated, from dependencies it has created, and from prior commitments it continues to administer. An institution may therefore remain responsible for maintenance, disclosure, review, or repair after the individuals who made the original decision have left.

Rules and routines are central because they shape repeated action. A harmful outcome can emerge from ordinary procedure even when no individual intended it. Responsibility analysis should then ask whether the institutional design created predictable blind spots, weak escalation, perverse incentives, inaccessible contestability, or inadequate maintenance. This analysis remains compatible with individual responsibility where particular actors also had relevant authority and knowledge.

Definition 10.359 (Institutional responsibility profile). An *institutional responsibility profile* records the institution's mandate, decision rights, operational capacities, dependencies, recurring duties, information channels, memory systems, maintenance obligations, review procedures, and capacity for repair or revision.

Institutional memory is especially important. Responsibility that depends entirely on personal recollection can disappear through turnover. Records, version histories,

handoff procedures, archival practices, recurring review, and explicit ownership of unresolved issues allow responsibilities to persist beyond individual tenure. These mechanisms connect institutional responsibility to traceability in Subsection 10.13.8.

Institutions can also generate responsibilities by creating reliance. Once others organize their activities around a service, infrastructure, standard, or guarantee, abrupt institutional withdrawal can impose consequences beyond the original transaction. Such reliance can create responsibilities for transition, notice, portability, handoff, or mitigation while still permitting legitimate institutional change.

Definition 10.360 (Responsibility continuity). *Responsibility continuity* is the preservation of an institution's capacity to recognize, carry, transfer, and discharge practical responsibilities across personnel turnover, organizational change, delegation, and extended time horizons.

Institutional responsibility also includes responsibility for learning. Recurrent failures that remain isolated as individual errors can persist. An institution capable of aggregating incidents, identifying patterns, revising procedures, and disseminating learning has a different responsibility architecture from one that repeatedly resets after each event.

Proposition 10.361 (Institutional responsibility across turnover). *Where organized mandates, capacities, dependencies, and consequences persist across personnel changes, responsibility can attach to the institution through the continuing practical relation across successive individual tenures.*

10.13.7 Accountability

Responsibility and effective answerability can diverge. Accountability concerns the practical architecture through which responsibilities become visible, reviewable, challengeable, and connected to response. It therefore links the responsibility relations developed above to the contestability architecture of Section 10.12.

Definition 10.362 (Practical accountability). *Practical accountability* is the organized condition under which a responsibility-bearing position can be required to provide reasons, disclose relevant records, undergo appropriately independent scrutiny, respond to findings, and participate in correction, remedy, or revision where warranted.

Accountability contains several functions. *Answerability* concerns the duty to explain and justify. *Reviewability* concerns the capacity of an authorized or legitimate forum to examine the relevant record. *Responsiveness* concerns the requirement to address findings and connect them to practical response. *Corrective capacity* concerns the possibility of repair, remedy, redesign, sanction, or reopening where appropriate. *Learning capacity* concerns preservation of the result so that later praxis can change.

Definition 10.363 (Accountability architecture). An *accountability architecture* is the arrangement of responsibility assignments, disclosure duties, review forums, evidential access, independence safeguards, response requirements, remedies, escalation pathways, and learning mechanisms through which consequential praxis becomes practically answerable.

The quality of accountability depends on fit between the forum and the practical object. Technical questions can require specialized review. Distributional questions can require access by affected positions. Institutional conflicts of interest can require

independent scrutiny. Urgent situations can require rapid review pathways, while long-horizon effects can require periodic reassessment. A single accountability mechanism is therefore unlikely to be adequate across every stage and object of application-dominant praxis.

Accountability can also become performative in a weak sense: reports are produced, hearings occur, or metrics are disclosed while practical corrective capacity remains weak. The architecture developed here therefore requires a response pathway. Explanation alone can be valuable, but consequential responsibility often requires the possibility of action after explanation.

Excessive accountability burden can also impair praxis. Duplicative reporting, fragmented audits, incompatible metrics, and constant approval requirements can consume operational capacity and discourage responsible adaptation. Accountability design should therefore be proportionate to consequence, uncertainty, power concentration, reversibility, and the existing quality of internal controls.

Definition 10.364 (Accountability fit). *Accountability fit* is the degree to which an accountability process is appropriately matched to the practical object's consequence, uncertainty, power distribution, technical complexity, temporal horizon, and available forms of correction.

Accountability is therefore neither a synonym for punishment nor a final-stage audit. Properly designed, it is part of the practical system through which responsibility becomes operational, contestability becomes consequential, and institutional learning becomes possible.

Proposition 10.365 (Accountability as response architecture). *Accountability becomes practically substantive when answerability and review are connected to usable capacities for correction, remedy, escalation, learning, or reopening proportional to the responsibilities under examination.*

10.13.8 Traceability

Accountability depends on the possibility of reconstructing how consequential praxis developed. Traceability concerns this reconstruction. It connects evidence, assumptions, problem formulations, decisions, implementation changes, monitoring, dissent, evaluation, and revision through a recoverable provenance structure.

Definition 10.366 (Practical traceability). *Practical traceability* is the capacity to reconstruct the materially relevant sequence linking problem formulation, evidence, assumptions, roles, decisions, actions, deviations, monitoring, consequences, evaluations, and revisions within a practical process.

Traceability supports several functions. It permits later reviewers to identify what knowledge was available at a decision point. It records who held which authority. It distinguishes an authorized plan from local implementation changes. It preserves dissent and warnings. It connects observed consequences to the versions of the intervention under which they occurred. It also supports institutional learning by making prior reasoning and adaptation recoverable.

Definition 10.367 (Practical provenance chain). *A practical provenance chain* is a linked record of the principal sources, transformations, decisions, role assignments, implementation states, observations, evaluations, and revisions through which a practical commitment develops over time.

Traceability should be selective enough to remain usable. Recording every interaction can create unusable archives, high administrative burden, privacy risks, strategic surveillance, or false confidence that what is documented exhausts what mattered. A traceability architecture therefore requires a materiality principle: preserve the information necessary to reconstruct consequential reasoning, authority, change, and response while protecting information whose collection or retention would create disproportionate harm.

Definition 10.368 (Traceability materiality). *Traceability materiality* is the criterion by which a practical process identifies which decisions, assumptions, changes, warnings, observations, role transitions, and consequences are sufficiently important to require durable provenance.

Traceability also has a relational dimension. Records can be technically complete while inaccessible to the actors who need them. Different participants may require different views: affected subjects may need understandable explanations; auditors may need detailed provenance; implementers may need operational change logs; decision-holders may need threshold and uncertainty records. Access design should therefore reflect legitimate role, privacy, security, and contestability requirements.

Automation can increase traceability by recording versions, timestamps, transformations, and decision pathways, but automated records still require interpretation. A log can show that an output was generated while leaving the appropriateness of the underlying assumptions for substantive evaluation. Traceability preserves reconstructability; substantive responsibility and correctness require further analysis.

Definition 10.369 (Traceability gap). A *traceability gap* is a materially relevant discontinuity in the practical provenance chain that prevents reliable reconstruction of a consequential decision, role transition, implementation change, warning, observation, or revision.

Traceability gaps can become responsibility gaps because later actors can lose the basis for directing review, repair, or learning. Conversely, excessive traceability requirements can themselves create exclusion or surveillance. The appropriate architecture therefore balances reconstructability with privacy, proportionality, accessibility, and operational feasibility.

Proposition 10.370 (Traceability and responsible revision). *Practical revision is more accountable when the principal grounds, role assignments, implementation changes, consequences, and prior responses remain reconstructable through a proportionate provenance chain.*

10.13.9 Long-Horizon Responsibility

Some consequences emerge after the decision cycle that produced them has ended. Infrastructures require maintenance, institutional classifications persist, ecological or social effects accumulate, capabilities decay or grow, dependencies become entrenched, and future actors inherit action spaces shaped by commitments formed before their participation. Long-horizon responsibility concerns the practical obligations created by this temporal extension of consequence.

Definition 10.371 (Long-horizon responsibility). *Long-horizon responsibility* is responsibility for consequences, dependencies, maintenance burdens, option structures, and revision needs that persist, accumulate, or become visible beyond the

immediate decision and implementation horizon.

Long-horizon responsibility is especially relevant to path-creating commitments introduced in Section 10.10. A decision can appear reversible during initial implementation while gradually generating standards, dependencies, sunk investments, skill distributions, or institutional expectations that narrow later possibilities. Responsibility therefore includes attention to the temporal profile through which reversibility changes.

Maintenance is one component. Durable interventions should specify who will maintain, finance, monitor, repair, decommission, or transfer them. Review is another. A commitment justified under one evidential or social condition can persist after those conditions change unless periodic reassessment is built into the architecture. Handoff is a third. Responsibilities need to survive personnel turnover, organizational restructuring, and the transfer of assets or authority.

Definition 10.372 (Responsibility horizon). A *responsibility horizon* is the temporal range over which a practical actor or institution is expected to preserve attention, maintenance, monitoring, review, repair, or transfer arrangements for consequences generated by its commitments.

Responsibility horizons can differ among practical objects. A temporary communication campaign can require a short monitoring horizon, while a durable infrastructure or long-lived institutional rule can require continuing stewardship. The horizon should therefore be matched to persistence, irreversibility, latency of consequence, maintenance dependency, and the availability of future corrective action.

Long-horizon responsibility also concerns future agency. Present actors can preserve or foreclose options, transfer unresolved risks, create maintenance obligations, or shape the capabilities through which later actors respond. A generative-relational perspective therefore asks what practical conditions are handed forward in addition to what immediate outcome is produced.

Definition 10.373 (Temporal stewardship). *Temporal stewardship* is the organized preservation of monitoring, maintenance, memory, option awareness, handoff capacity, and revision pathways needed for future actors to respond responsibly to consequences inherited from earlier praxis.

Temporal stewardship preserves the autonomy of future practical judgment. Its role is to preserve relevant information, maintain necessary capacities, limit unnecessary foreclosure, document inherited burdens, and keep revision pathways available where this is practicable. This creates a bridge from responsibility to justice because future actors can inherit benefits, burdens, risks, exclusions, opportunities, and institutional structures that were generated before they acquired practical voice.

The architecture of responsibility and accountability developed in this section therefore extends across the full practical sequence. Decision responsibility concerns warranted commitment. Action responsibility concerns competent execution, adaptation, maintenance, and repair. Inaction responsibility concerns consequential omissions under relevant conditions of capacity and standing. Responsibility under uncertainty concerns characterization, calibration, monitoring, updating, and burden allocation. Distributed responsibility maps differentiated contributions and interfaces. Institutional responsibility preserves obligations across organized structures and turnover. Accountability makes responsibility answerable and responsive. Traceability preserves the provenance required for review and learning. Long-

horizon responsibility carries practical attention beyond the immediate decision cycle.

Proposition 10.374 (Responsibility across generative consequence). *Where praxis generates durable consequences, dependencies, capabilities, burdens, or option structures, responsibility can extend beyond the initiating decision to the maintenance, monitoring, handoff, repair, and revision conditions through which those consequences continue to shape later practical situations.*

Responsibility establishes which practical structures can be expected to answer for consequential praxis. Justice adds evaluation of how benefits, burdens, risks, participation, recognition, relational position, generative opportunity, historical consequence, and inherited conditions are distributed under heterogeneous forms of value. Section 10.14 therefore turns to justice in application-dominant praxis.

10.14 Justice in Application-Dominant Praxis

Section 10.13 established responsibility and accountability as architectures for connecting consequential praxis to answerability, review, repair, learning, and long-horizon stewardship. Justice adds a different practical question. It asks how the benefits, burdens, risks, participatory positions, forms of recognition, relational structures, generative opportunities, historical inheritances, and future conditions produced or preserved by praxis are distributed across heterogeneous positions. The present section develops this question at the general level of application-dominant praxis. Its objective is to identify principal dimensions through which justice enters practical judgment without reducing them to a single distributive metric or importing a complete substantive theory of justice. The discussion proceeds analytically across benefits, burdens, risk, participation, recognition, relations, generative opportunity, historical inheritance, intergenerational consequence, and heterogeneous value. Each dimension is treated as a distinct but interacting object of practical assessment.

Justice in this chapter functions as a landscape of practical evaluation. Application-dominant praxis frequently changes who receives advantages, who carries costs, who is exposed to uncertainty, who can participate, whose experiences become legible, which relations are strengthened, and what possibilities remain available later. Some of these changes can be represented quantitatively; others remain qualitative, relational, historical, or interpretive. The purpose of the present framework is therefore to preserve the plurality of justice-relevant objects while making their practical relations traceable.

Definition 10.375 (Justice profile in application-dominant praxis). *A justice profile in application-dominant praxis is a structured account of how a practical commitment distributes or transforms benefits, burdens, risks, participatory standing, recognition, relational position, generative opportunity, historical consequence, and future conditions across relevant positions and temporal horizons.*

A justice profile is neither a complete moral theory nor a scalar score. It is an analytical record that makes justice-relevant consequences visible for judgment, contestation, and revision. Its components can support different normative interpretations. Some practical contexts can justify relatively clear thresholds; others can contain persistent disagreement about the relative importance of the dimensions. Preserving that disagreement is often more informative than translating every concern into one

Table 10.14: Principal justice dimensions in application-dominant praxis.

Dimension	Primary practical object	Characteristic question	Characteristic concern
Benefits	Advantage, capability, access, relief, opportunity	Who receives which practical gains, when, and under what conditions?	Concentration, exclusion, unequal usability, delayed access
Burdens	Cost, effort, obligation, disruption, sacrifice	Who carries implementation, adaptation, maintenance, and residual burdens?	Burden transfer, overload, hidden labor, recovery asymmetry
Risk	Exposure to uncertain adverse consequence	Who is exposed, who authorizes exposure, and who can recover?	Risk transfer, asymmetric protection, tail exposure, weak recovery capacity
Participation	Standing, voice, influence, contestability	Which affected positions can enter which stages of praxis?	Formal inclusion without influence, participation burden, inaccessible review
Recognition	Legibility, standing, category, respect	Which subjects, experiences, identities, and claims become practically intelligible?	Omission, distortion, stigmatizing categories, epistemic invisibility
Relational justice	Dependence, authority, reciprocity, domination, care	What kinds of relations are created, preserved, or weakened?	Durable subordination, one-sided dependence, weakened agency, unaccountable authority
Generative opportunity	Future capacity to act, learn, create, revise, and participate	Whose future practical possibilities are expanded or contracted?	Capability concentration, foreclosure, dependence, unequal future agency
Historical justice	Inherited structure and accumulated consequence	How do earlier decisions, exclusions, benefits, and burdens shape present positions?	Path dependence, inherited disadvantage, unaddressed legacy, historical erasure
Across generations	Conditions transferred across temporal horizons	What benefits, burdens, risks, capacities, and options are handed forward?	Deferred costs, maintenance debt, irreversible loss, constrained future judgment
Heterogeneous values	Plural and partly non-commensurable goods	How can justice be evaluated when relevant values resist reduction to one scale?	Forced commensuration, hidden trade-offs, value erasure, opaque priority rules

commensurable quantity.

Table 10.14 separates justice-relevant objects that can otherwise be merged under broad language of fairness or distribution. The dimensions interact. A benefit can create a burden elsewhere. Participation can alter recognition. Recognition can change which risks become visible. Relational arrangements can determine who can convert formal opportunities into effective capability. Historical structures can shape present exposure, while present decisions can transfer long-lived conditions to future actors. The separation therefore supports analysis rather than conceptual isolation.

Definition 10.376 (Justice-relevant transformation). A *justice-relevant transformation* is a change in practical conditions that materially alters the distribution, accessibility, recognition, relational structure, or temporal inheritance of one or more justice-relevant objects across affected positions.

The definition includes both direct and indirect effects. An intervention can distribute a material benefit directly while indirectly changing status, bargaining capacity, mobility, dependence, or access to later opportunities. A practical justice analysis

should therefore follow the transformation beyond the immediate output where later generative effects are material to the situation.

10.14.1 Benefits

Benefits are among the most visible objects of justice analysis, yet their practical structure extends beyond the presence or quantity of an advantageous outcome. Application-dominant praxis can generate relief, access, capability, security, knowledge, recognition, institutional support, improved environmental conditions, reduced exposure, or expanded practical possibility. Justice analysis asks how these benefits are distributed, whether they are usable, how long they persist, what conditions attach to them, and which positions remain outside their reach.

Definition 10.377 (Practical benefit). A *practical benefit* is a positively valued change in condition, relation, capability, access, protection, recognition, or future possibility generated, preserved, or made more reachable through praxis.

Benefit should therefore be distinguished from nominal allocation. A resource, service, right, or opportunity can be formally provided while remaining difficult to use because of distance, language, timing, eligibility, administrative complexity, technological requirements, social stigma, or dependence on complementary capacities. Justice analysis should consequently examine both distribution and convertibility into practical advantage.

Definition 10.378 (Benefit-conversion condition). A *benefit-conversion condition* is a practical condition required for a nominally available good, protection, service, capability, or opportunity to become an effectively usable benefit for a particular position.

Conversion conditions can vary across positions. Identical formal provision can produce unequal effective benefit where actors differ in access, time, knowledge, mobility, institutional standing, complementary resources, or capacity to bear activation costs. Equality of nominal distribution can therefore coexist with inequality of practical benefit.

Temporal structure also matters. Benefits can arrive immediately, accumulate gradually, depend on continued maintenance, or remain contingent on future institutional support. A short-term gain can be accompanied by a long-term loss of autonomy or option space. Conversely, a temporary burden can support durable capability or protection. Benefit analysis should therefore record both immediate and generative effects where the latter are material.

Definition 10.379 (Benefit-distribution profile). A *benefit-distribution profile* records the form, magnitude where appropriate, accessibility, timing, duration, conversion conditions, and relevant generative consequences of practical benefits across affected positions.

Benefits can also be relational. An intervention can improve a person's position by reducing dependence, increasing bargaining capacity, making participation easier, or creating a credible exit option. These effects may be poorly captured by output measures while remaining central to practical justice. The benefit profile should therefore remain open to relational and qualitative forms of advantage.

Proposition 10.380 (Benefits and practical accessibility). A *justice assessment of benefits* is more complete when it distinguishes nominal provision from the position-specific conditions through which that provision becomes effectively accessible, usable, and ca-

pable of supporting later practical agency.

10.14.2 Burdens

Application-dominant praxis distributes burdens as well as benefits. Burdens can include financial cost, physical exposure, time, administrative labor, emotional strain, displacement, adaptation effort, monitoring duties, maintenance obligations, reduced privacy, loss of convenience, constrained choice, or the work required to make an intervention function. Some burdens are visible in budgets and plans. Others remain distributed through everyday labor, informal care, compliance effort, or repeated coordination.

Definition 10.381 (Practical burden). A *practical burden* is a cost, effort, obligation, exposure, loss, constraint, disruption, or maintenance requirement borne by a position as part of, or as a consequence of, consequential praxis.

Burdens should be examined independently of benefits because net aggregation can conceal who carries the costs of producing gains elsewhere. A programme can generate substantial aggregate benefit while concentrating disruption or maintenance obligations on a smaller group. Conversely, a burden borne by one actor can be voluntarily undertaken to protect others. Justice analysis therefore requires distributional structure in addition to aggregate consequence.

Capacity to bear a burden is also relevant. The same nominal cost can have very different practical effects across positions with different resources, health, time, social support, mobility, or recovery capacity. This does not imply that every burden should be equalized mechanically. It indicates that burden significance depends partly on the relation between the burden and the position that receives it.

Definition 10.382 (Burden-capacity relation). A *burden-capacity relation* describes how the practical significance of a burden varies with the affected position's resources, alternatives, dependencies, recovery capacity, obligations, and ability to contest or redistribute that burden.

Hidden burdens are especially important in distributed praxis. Participation can require unpaid time. Digital systems can transfer administrative work from institutions to users. Safety requirements can impose documentation labor on front-line staff. Exit can transfer maintenance or repair obligations to those who remain. These effects should be traced across implementation and long-horizon responsibility rather than treated as external to the intervention.

Burden transfer can also occur through institutional design. A decision-maker can reduce its own operational uncertainty by requiring affected actors to absorb variability, documentation, waiting, or adaptation. Such arrangements can be practically efficient in one dimension while creating concentrated burdens elsewhere. Justice analysis should make the transfer explicit before deciding whether it is acceptable.

Definition 10.383 (Burden-distribution profile). A *burden-distribution profile* records the type, intensity where appropriate, duration, recoverability, transfer pathway, bearing capacity, and contestability of relevant practical burdens across affected positions.

Proposition 10.384 (Burden visibility). A *practical arrangement can appear favorable under aggregate outcome measures while remaining justice-relevant where implementation, maintenance, adaptation, or residual burdens are concentrated on positions with*

limited capacity to absorb, contest, or transfer them.

10.14.3 Risk

Section 10.10 developed risk as a relational consequence structure involving exposure, uncertainty, propagation, vulnerability, and recovery capacity. Justice adds the question of how those elements are distributed. The actor authorized to create risk can differ from the actor exposed to it. Those receiving expected benefits can differ from those carrying tail exposure. Those best positioned to recover can differ from those facing the greatest downside. Risk justice therefore cannot be inferred from expected aggregate outcome alone.

Definition 10.385 (Risk-distribution justice profile). *A risk-distribution justice profile* records which positions authorize, generate, benefit from, are exposed to, monitor, absorb, recover from, and remain responsible for materially relevant practical risks.

Risk distribution has an epistemic dimension. Some actors can possess better information about exposure than others. Affected positions may be asked to accept uncertain consequences without equivalent access to evidence or to the assumptions used in risk characterization. Section 10.13 treated uncertainty communication as a responsibility; justice analysis asks whether information asymmetry itself changes the distribution of practical agency and exposure.

Consent can matter while remaining insufficient as a complete account. A position may formally accept a risk because alternatives are weak, dependence is high, or exit is costly. Conversely, some risks cannot feasibly be individualized because consequences propagate through shared systems. The practical structure of authorization, dependence, and collective exposure should therefore accompany any record of consent.

Tail risk creates a further problem. A low-probability or poorly characterized adverse consequence can be concentrated on actors who receive little expected benefit and possess limited recovery capacity. Even where aggregate expected value appears favorable, the asymmetry of catastrophic exposure can remain justice-relevant. This is one reason why reversibility, containment, redundancy, and option preservation carry both risk-management and justice significance.

Definition 10.386 (Risk-exposure asymmetry). *Risk-exposure asymmetry* is a practical configuration in which the authority to create, authorize, or benefit from a risk is separated from the position that bears a disproportionate share of its downside exposure or recovery burden.

Risk can also be redistributed through protection. Insurance, reserves, fallback systems, emergency capacity, legal remedy, redundancy, or public infrastructure can reduce the burden of adverse realization. Justice analysis should therefore ask not only who faces the probability of harm but also who possesses access to protection and recovery.

Proposition 10.387 (Risk and distributed exposure). *Where authority, benefit, exposure, information, and recovery capacity occupy different positions, justice analysis should preserve these separations rather than representing practical risk only through an aggregate probability or expected loss.*

10.14.4 Participation

Section 10.12 developed participation as a distributed relation across problem recognition, evidence formation, interpretation, end specification, option generation, decision, implementation, monitoring, evaluation, contestation, and revision. Justice enters this architecture through questions of standing, access, influence, burden, representation, and the ability to challenge practical closure. Participation can therefore be both a means of improving decisions and a justice-relevant practical condition in its own right.

Definition 10.388 (Participatory justice profile). A *participatory justice profile* records which affected positions possess access, voice, influence, representation, contestability, information, support, and withdrawal options across the stages of a practical process.

Participation quality depends on where participation enters. Consultation after the principal problem, ends, and option set have already been fixed provides a different form of agency from participation in problem construction or option generation. Likewise, access to comment differs from power to require a response, reopen a decision, or alter implementation. A participatory justice profile should therefore record stage and practical effect rather than merely counting participants.

Participation also distributes burdens. Meetings require time. Consultation can require disclosure of sensitive experience. Representation can create emotional and interpretive labor. Repeated requests for community input can transfer problem-definition work onto affected groups without transferring corresponding authority or resources. Justice analysis should therefore preserve the participation-burden profile introduced in Section 10.12.

Unequal participation can also arise from institutional language, technical complexity, disability, digital access, migration status, care responsibilities, professional norms, or fear of retaliation. Formal inclusion becomes practically weak when these conversion barriers remain unaddressed. Participation support can therefore include translation, compensation, accessibility, confidentiality, technical assistance, protected time, and procedural explanation.

Definition 10.389 (Participatory standing). *Participatory standing* is the recognized practical basis on which an affected or relevant position is entitled to enter, influence, contest, or seek review of specified stages of consequential praxis.

Participatory standing need not imply identical authority for every actor across every decision object. Technical implementation, rights protection, collective resource allocation, and individualized consent can require different decision-rights architectures. Justice analysis concerns whether the differentiation is warranted, visible, contestable, and appropriately related to affectedness, expertise, responsibility, and consequence.

Proposition 10.390 (Participation across practical stages). *Participatory justice is better assessed through the distribution of standing, influence, support, burden, and contestability across practical stages than through presence at a single decision point.*

10.14.5 Recognition

Application-dominant praxis depends on categories through which actors, conditions, harms, capabilities, evidence, and claims become legible. Recognition concerns the

practical standing produced through these interpretive structures. Some subjects can remain outside the categories through which institutions observe a problem. Others can be visible only through classifications that distort their experience, reduce their agency, or attach stigmatizing assumptions. Justice therefore includes the conditions under which relevant positions are recognized as subjects of concern, knowledge, participation, and practical agency.

Definition 10.391 (Practical recognition). *Practical recognition* is the condition in which a subject, group, relation, experience, capability, or claim becomes legible within praxis in a form sufficiently adequate to support appropriate consideration, standing, participation, and response.

Recognition has an epistemic dimension because what remains unrecognized can disappear from evidence architectures. It has a participatory dimension because standing often depends on categorical inclusion. It has a relational dimension because categories can encode hierarchy, dependency, or deficit. It also has a temporal dimension because historically inherited classifications can continue to shape present access even after their original justification has weakened.

Recognition should not be equated with visibility alone. Visibility can coexist with distortion. A group may be intensely measured while its own account of the relevant problem remains institutionally weak. Conversely, privacy or autonomy can make reduced visibility desirable in some contexts. Justice analysis should therefore examine the terms of recognition, the agency available in defining those terms, and the consequences attached to categorical placement.

Definition 10.392 (Recognition gap). A *recognition gap* is a materially relevant mismatch between an affected practical reality and the categories, records, representations, or institutional standing through which that reality is made intelligible for consequential praxis.

Recognition gaps can take several forms. A subject can be omitted entirely. A relation can be observed only through one side. A harm can be registered as individual failure while its relational or institutional generation remains invisible. A capability can be overlooked because evaluation records only deficits. A collective can be treated as homogeneous despite internally unequal positions. These gaps connect recognition to the problem-formation architecture of Section 10.4.

Recognition can also change through praxis. New categories, testimony, data, participatory processes, or institutional learning can make previously obscured conditions visible. Such changes should remain revisable because recognition categories can themselves produce new exclusions.

Proposition 10.393 (Recognition and practical legibility). *Justice-relevant recognition requires attention to the adequacy, consequences, and revisability of the categories through which affected positions become practically legible, in addition to their mere visibility within the decision process.*

10.14.6 Relational Justice

Benefits, burdens, and risks can be distributed through relations that themselves deserve evaluation. An intervention can improve an outcome while increasing one-sided dependence. It can expand access while weakening exit. It can reduce uncertainty for a central institution by transferring adaptation demands to peripheral ac-

tors. Conversely, a practical arrangement can strengthen reciprocal capacity, reduce arbitrary dependence, improve contestability, or distribute authority more responsively. Relational justice concerns these structural properties of the relations through which praxis operates.

Definition 10.394 (Relational justice). *Relational justice* is the justice-relevant assessment of how consequential praxis constitutes, preserves, or transforms relations of dependence, authority, reciprocity, recognition, care, coordination, contestability, and practical agency among affected positions.

The relational perspective supplements outcome distribution. Two arrangements can produce similar immediate benefits while creating different future dependencies. One may require continuous permission from a central actor; another may transfer capability to local actors. One may permit meaningful contestation and exit; another may make access conditional on continued compliance. These differences can become especially important when the intervention persists over time.

Dependence is not inherently unjust. Practical life contains extensive interdependence, specialization, delegation, and care. The relevant questions concern form, asymmetry, necessity, contestability, reciprocity, alternatives, and the consequences of withdrawal. A relation can be asymmetric while remaining legitimate under conditions of limited scope, accountability, competence, and meaningful review. A relation can also become problematic when one side acquires durable control over essential conditions without proportionate answerability or exit.

Definition 10.395 (Relational justice profile). A *relational justice profile* records the principal dependencies, authority relations, reciprocities, asymmetries, exit conditions, contestability pathways, and agency effects generated or preserved by a practical arrangement.

Relational justice also connects to power conversion in Section 10.11. A resource asymmetry becomes justice-relevant when the surrounding relations convert it into durable capacity to define problems, impose burdens, withhold action, control measurement, or foreclose alternatives. The profile should therefore include the institutional conditions that amplify or constrain asymmetry.

A further issue concerns care and support relations. Increasing autonomy in one dimension can remove valuable forms of dependable support if independence is treated too narrowly. Relational justice therefore benefits from examining the quality and revisability of interdependence rather than assuming that reduced dependence is always preferable.

Proposition 10.396 (Justice through relational structure). *Where practical arrangements generate durable relations of dependence, authority, reciprocity, care, or contestability, justice analysis should evaluate the structure of those relations in addition to the immediate distribution of outcomes they produce.*

10.14.7 Generative Opportunity

Section 10.7 treated action space as a dynamic structure of available, latent, foreclosed, and generated possibilities. Section 10.6 introduced generative value at the general GR level as value associated with enabling, sustaining, diversifying, regenerating, or deepening later possibilities for valued generation. Justice adds a positional question: whose capacities to generate later action, learning, interpretation, coor-

dination, creation, revision, and value are expanded or contracted through present praxis?

Definition 10.397 (Generative opportunity). *Generative opportunity* is a position's effective practical capacity to participate in, initiate, revise, sustain, or benefit from future processes of valued generation across relevant relational and temporal settings.

Generative opportunity differs from possession of a single present benefit. A short-term transfer can improve immediate conditions without altering the capabilities or relations through which future options are produced. Another intervention can generate durable knowledge, confidence, infrastructure, networks, rights, institutional access, or collective capacity that changes later possibility. Justice analysis should be capable of distinguishing these effects without assuming that generative expansion is sufficient for justice by itself.

Generative opportunity can also be concentrated. An intervention may expand the future option space of powerful actors while making weaker positions more dependent on those actors. Technology can create extensive new capability for some while narrowing the ability of others to contest or exit. Institutional reforms can create new forms of participation while increasing the expertise required to use them. The distribution of generative capacity is therefore as important as its aggregate growth.

Definition 10.398 (Generative-opportunity profile). A *generative-opportunity profile* records how praxis changes position-specific capacities for learning, acting, coordinating, creating, revising, refusing, exiting, participating, and generating later practical options.

The profile should distinguish expansion from dependence-mediated access. A position may gain access to new possibilities only while a central provider remains willing to supply infrastructure, permissions, or data. Such access can still be valuable, but its dependency structure matters for long-horizon agency. Generative opportunity therefore connects directly to relational justice and temporal stewardship.

Protective limits can also support generative opportunity. Some constraints preserve attention, health, ecological conditions, institutional reliability, or shared resources needed for later generation. An unrestricted increase in immediate options can sometimes erode the conditions from which future options emerge. Justice analysis should consequently examine the temporal and relational conditions of generativity rather than treating option quantity as an adequate proxy.

The later GRE parts will develop economic questions of heterogeneous value, conversion, circulation, return, capture, dissipation, and regeneration in greater specificity. The present subsection remains at the general GR level: its purpose is to establish future generative capacity as a justice-relevant object of praxis.

Proposition 10.399 (Distribution of generative opportunity). *Where present praxis materially changes who can generate, revise, sustain, or access later practical possibilities, the distribution of those generative opportunities belongs to the justice profile of the intervention in addition to its immediate outcome distribution.*

10.14.8 Historical Justice

Practical positions are historically formed. Present differences in capacity, exposure, recognition, institutional access, trust, wealth, infrastructure, or authority can reflect earlier decisions and accumulated relations. A purely contemporaneous snapshot

can therefore obscure the processes through which current advantages and disadvantages became possible. Historical justice introduces temporal reconstruction into practical evaluation.

Definition 10.400 (Historical justice profile). A *historical justice profile* is a reconstruction of materially relevant past decisions, relations, exclusions, transfers, burdens, benefits, recognitional structures, and institutional inheritances that contribute to the present justice-relevant configuration.

Historical relevance should be established rather than assumed. A past event matters for current praxis when a plausible continuity connects it to present conditions through institutions, property, infrastructure, categories, obligations, capabilities, environmental effects, social memory, or other durable relations. Temporal distance alone neither erases nor establishes practical relevance.

The profile can identify several kinds of inheritance. Benefits can accumulate across time. Burdens can persist through debt, degraded environments, lost capability, exclusion, or institutional mistrust. Categories can carry earlier assumptions into present decision systems. Infrastructure can embody previous priorities. Earlier harms can alter the capacity of affected positions to participate in current processes. These inheritances can influence what present actors can reasonably be expected to contribute or bear.

Definition 10.401 (Historical carryover). *Historical carryover* is a continuing practical effect through which an earlier decision, relation, institution, classification, transfer, or consequence materially shapes the present distribution of agency, benefit, burden, risk, recognition, or opportunity.

Historical justice also raises questions of response. Possible responses can include acknowledgment, restoration, institutional redesign, repair, preservation of memory, change in classification, transfer of capacity, or alteration of decision rights. The appropriate form depends on the continuity between past and present, the nature of the inherited consequence, current affected positions, available forms of repair, and the risk of generating additional harm through response.

Historical analysis should remain open to multiple scales. A local practical problem can carry institutional history, community memory, legal history, technological history, ecological change, or organizational path dependence. The relevant scale should be chosen according to the generative pathways that remain active in the present situation.

Proposition 10.402 (Historical continuity and present justice). *Past conditions become practically relevant to present justice where identifiable historical carryovers continue to shape current agency, exposure, recognition, responsibility, access, or opportunity through durable relational pathways.*

10.14.9 Intergenerational Justice

Long-horizon responsibility in Section 10.13 established that present actors can create maintenance burdens, durable dependencies, path-created commitments, and inherited option structures extending beyond the immediate decision cycle. Intergenerational justice evaluates the conditions transferred across those temporal horizons. Future actors can inherit benefits and infrastructures while also inheriting debt, risk, environmental degradation, maintenance obligations, locked standards, reduced op-

tion spaces, or incomplete records needed for revision.

Definition 10.403 (Intergenerational justice profile). An *intergenerational justice profile* records the benefits, burdens, risks, capabilities, institutional conditions, information, maintenance requirements, and option structures that present praxis is expected to transfer to later practical actors.

Future actors occupy a distinctive participatory position because they cannot enter present deliberation in the same way as current affected subjects. Representation is therefore indirect. Present decision processes can use long-horizon scenario analysis, stewardship institutions, maintenance funds, preservation rules, periodic review, reversibility protections, archival practices, or explicit future-impact criteria to make later conditions more visible. These devices remain imperfect and should be treated as practical proxies rather than as literal substitutes for future voice.

A central question concerns inherited option space. Present actors can preserve flexibility for future judgment, but preservation itself can have costs. Maintaining redundant infrastructure, withholding irreversible development, or financing long-term monitoring can burden current actors. Conversely, maximizing present flexibility can leave future actors with weak commitments, inadequate infrastructure, or deferred problems. Intergenerational justice therefore involves balancing transferred capacity, burden, and option structure rather than simply maximizing open possibilities.

Definition 10.404 (Future-agency preservation). *Future-agency preservation* is the practical effort to maintain sufficient information, capability, environmental and institutional conditions, and revisable option structures for later actors to exercise meaningful judgment over consequences inherited from present praxis.

Irreversibility sharpens this problem. Some present decisions can eliminate conditions that later actors cannot restore. Where consequences are durable and uncertain, preservation of future agency can support stronger requirements for precaution, modularity, monitoring, or justified constraint on present commitment. The appropriate threshold depends on the magnitude, persistence, recoverability, and distribution of the relevant consequence.

Intergenerational justice also includes continuity of memory. Later actors cannot responsibly revise inherited arrangements if the reasons, assumptions, risks, responsibilities, and alternatives surrounding their creation have disappeared. Temporal stewardship therefore has a justice dimension: provenance and institutional memory can become part of what one generation owes to later practical judgment.

Proposition 10.405 (Justice and inherited practical conditions). *Where present praxis materially shapes the benefits, burdens, risks, capabilities, records, or option structures available to later actors, those inherited practical conditions belong to the justice assessment of the present commitment.*

10.14.10 Justice under Heterogeneous Values

The preceding dimensions rarely enter practical judgment through a single common measure. Benefits can concern health, autonomy, knowledge, security, ecological integrity, recognition, cultural continuity, capability, or social relation. Burdens can concern money, time, dignity, exposure, displacement, attention, dependence, or irreversible loss. Participation and recognition have forms that resist reduction to the

units used for material allocation. Generative opportunity can concern future capacities whose value remains partly open. Justice under heterogeneous values therefore requires an architecture capable of practical comparison without assuming complete commensurability.

Definition 10.406 (Heterogeneous-value justice situation). A *heterogeneous-value justice situation* is a practical configuration in which materially relevant justice claims concern multiple forms of value whose ordering is partial, contested, context-sensitive, or not adequately representable through a single common scale.

Value heterogeneity does not prevent practical judgment. It changes the form of comparison. Some alternatives can be excluded because they violate a sufficiently established threshold. Some can be compared within a shared value dimension. Some can be ordered through agreed priority rules. Others can remain partially ordered, leaving several acceptable options whose differences must be described rather than collapsed. Deliberation can also reveal value conversions or previously hidden conflicts without making all values equivalent.

Definition 10.407 (Justice comparison architecture). A *justice comparison architecture* is the explicit set of thresholds, priority rules, partial orderings, conversion assumptions, protected values, unresolved conflicts, and revision conditions through which heterogeneous justice claims are compared for practical judgment.

The comparison architecture should disclose where commensuration occurs. Converting time, risk, ecological loss, dignity, cultural continuity, or future option space into a common metric can be useful for some purposes while obscuring other dimensions. Where conversion is used, its domain, assumptions, uncertainty, and remainder should remain visible. Where conversion is withheld, the resulting plurality should be carried into judgment rather than treated as a methodological failure.

Value conflict can also be relational. The same practical arrangement can embody different values for different positions. A shared place can function simultaneously as livelihood, heritage, habitat, infrastructure, memory, and future development option. Justice analysis should therefore record whose value articulation enters the decision, how translations are made across value forms, and which losses remain insufficiently represented by the chosen decision language.

Definition 10.408 (Justice remainder). A *justice remainder* is a materially relevant value, claim, loss, disagreement, or relational consequence that remains unresolved or inadequately represented after the principal comparison and decision architecture has been applied.

Preserving a justice remainder supports revisability. Some conflicts can become clearer after implementation. New affected positions can emerge. Consequences can reveal that an earlier metric was too narrow. Institutional values can change. Recording what remained unresolved at closure makes later reopening more accountable and reduces the tendency to reinterpret previous uncertainty as prior consensus.

Justice under heterogeneous values therefore complements the theory of practical judgment in Section 10.5. Practical judgment can integrate differentiated evaluative dimensions without claiming that they have become identical. It can support action where several values remain in tension, provided the comparison architecture, unresolved remainder, burden distribution, and revision conditions remain explicit.

Proposition 10.409 (Justice without complete commensurability). *Application-dominant praxis can reach a provisionally warranted justice-sensitive judgment under*

heterogeneous values by combining explicit thresholds, partial comparisons, transparent priority rules, preserved disagreement, and revisable practical closure without requiring all justice-relevant values to be reduced to one common measure.

Taken together, these dimensions extend justice analysis beyond outcome distribution. They preserve differences among accessibility, burden-bearing capacity, exposure, participation, recognition, relational position, generative opportunity, historical inheritance, intergenerational consequence, and heterogeneous value while allowing their interactions to remain visible.

Definition 10.410 (Integrated justice record). *An integrated justice record is a revisable account of the principal justice profiles, comparison rules, affected positions, unresolved remainder, and reopening conditions associated with a practical process.*

The record preserves disagreement where the dimensions point in different directions. An intervention can improve benefits while weakening participation, reduce one risk while transferring another, or expand aggregate opportunity while concentrating future generative capacity.

Proposition 10.411 (Justice as a multi-dimensional practical architecture). *Justice in application-dominant praxis is more adequately represented when its principal dimensions remain distinguishable within an integrated and revisable practical record.*

Justice analysis prepares the institutional level of the chapter. Application-dominant praxis is organized through collectives, roles, routines, infrastructures, mandates, and durable decision structures that condition how power, responsibility, participation, and justice are realized. Section 10.15 turns to these institutional and collective forms of praxis.

10.15 Institutional and Collective Praxis

Section 10.14 established justice as a multi-dimensional practical architecture spanning benefits, burdens, risk, participation, recognition, relational position, generative opportunity, historical inheritance, and future conditions. These dimensions are rarely realized through isolated actors. Application-dominant praxis is commonly organized through institutions and collectives whose mandates, capacities, constraints, memories, decision structures, coordination arrangements, cooperative relations, conflicts, and trust conditions shape what can be recognized, authorized, implemented, maintained, contested, and revised. The present section develops this institutional and collective layer. Its objective is to explain how consequential praxis acquires durability and distributed agency without treating institutions as unitary subjects or collectives as internally homogeneous. The discussion proceeds analytically from mandates, capacity, constraints, and memory to collective decision, coordination, cooperation, conflict, trust, and collective generativity.

The institutional perspective adds temporal and organizational thickness to the preceding analysis. Power can be stabilized through roles and procedures. Responsibility can persist across personnel turnover. Participation can become routinized or narrowed. Justice-relevant benefits and burdens can be reproduced through infrastructure, eligibility rules, categories, and maintenance practices. Trust can attach to procedures and institutional reliability in addition to particular persons. Collective agency can emerge from relations among actors whose individual capacities would be insufficient for the practical object. Institutions therefore belong to the generative

conditions of praxis rather than merely to its external setting.

Definition 10.412 (Institutional configuration). An *institutional configuration* is a relatively durable arrangement of roles, rules, mandates, authority relations, resources, routines, infrastructures, expectations, records, and practical interfaces that structures consequential praxis across more than one isolated episode.

Durability is relative. Some institutional configurations persist for decades, while others are temporary task structures created for a crisis, project, inquiry, or transition. What matters analytically is that they organize expectations and practical possibility beyond the immediate choice of one actor.

Definition 10.413 (Collective praxis). *Collective praxis* is consequential praxis whose formation, execution, maintenance, interpretation, or revision depends materially on the interdependent contributions of multiple positions organized around one or more shared, compatible, negotiated, or contested practical objects.

Collective praxis does not require complete consensus. A collective can contain disagreement, unequal authority, competing interpretations, and different reasons for participation while still producing a practical process that cannot be reduced to the acts of any one participant. The analytical task is therefore to reconstruct how differentiated contributions become organized into durable capacity and consequence.

Table 10.15 separates dimensions that often appear together in organizational descriptions. A formal mandate can exist without adequate capacity. Capacity can be high while coordination is weak. Cooperation can occur amid unresolved conflict. Trust can substitute for some monitoring while also creating vulnerability. Institutional memory can stabilize useful learning or preserve obsolete categories. Collective generativity depends on the interactions among these dimensions rather than on any one of them in isolation.

10.15.1 Institutional Mandates

Application-dominant praxis requires some account of who is authorized, expected, or recognized as competent to address a practical object. Institutional mandates organize this relation. They can arise through law, charter, contract, professional role, delegated authority, established convention, emergency arrangement, community recognition, or other durable sources of practical standing. A mandate therefore concerns the scope and grounds of institutional action rather than merely the existence of an organization.

Definition 10.414 (Institutional mandate). An *institutional mandate* is a recognized scope of practical authority, responsibility, or expected action through which an institution or collective is positioned to address specified objects, affected positions, processes, or consequences.

Mandates have boundaries. They can specify subject matter, territory, population, time horizon, procedural requirements, permissible means, reporting duties, or conditions for escalation. These boundaries structure the action space developed in Section 10.7. They can protect affected positions by limiting arbitrary intervention, while also creating gaps where consequential problems fall between institutional jurisdictions.

Definition 10.415 (Mandate topology). A *mandate topology* maps the practical objects and interfaces assigned to relevant institutions or collective roles, together with areas

Table 10.15: Principal dimensions of institutional and collective praxis.

Dimension	Primary practical object	Characteristic question	Characteristic concern
Mandates	Authorized or recognized scope of action	Which practical objects may or should the institution address?	Gaps, overlap, ambiguity, mandate–capacity mismatch
Capacity	Deployable ability to sense, decide, act, maintain, and revise	What can the institution or collective effectively accomplish?	Overload, bottlenecks, capability concentration, adaptive weakness
Constraints	Limits and conditions on institutional action	Which possibilities are restricted, protected, delayed, or conditioned?	Lock-in, procedural rigidity, resource scarcity, enabling limits
Memory	Records, routines, skills, categories, and inherited learning	What practical knowledge survives across episodes and personnel?	Amnesia, selective retention, inaccessible records, path dependence
Collective decision	Formation of authoritative practical commitment	How do differentiated inputs become a decision capable of organizing action?	Agenda control, aggregation, dissent, decision–implementation gaps
Coordination	Alignment of interdependent activities	How are timing, interfaces, information, and role dependencies organized?	Fragmentation, duplication, incompatible routines, cascading failure
Cooperation	Contribution toward shared or compatible practical ends	Under what conditions do actors sustain mutually supporting contribution?	Free riding, exclusion, unequal dependence, unstable reciprocity
Conflict	Structured divergence within or among practical actors	How are incompatible ends, interpretations, burdens, or claims handled?	Suppression, escalation, unresolved antagonism, hidden disagreement
Trust	Reliance under vulnerability and incomplete verification	Which expectations permit practical reliance, and how are they calibrated?	Overtrust, distrust, opacity, betrayal, weak repair pathways
Collective generativity	Capacity to create later capabilities and possibilities	What future practical capacities does collective organization generate or erode?	Lock-in, dependence, capability growth, institutional self-revision

of overlap, dependency, ambiguity, and unassigned responsibility.

Overlap is not inherently inefficient. Two institutions can retain partially overlapping mandates because independent review, redundancy, specialized expertise, or checks on concentrated authority are valuable. Overlap becomes problematic when authority, escalation, or responsibility remain sufficiently unclear that actors defer to one another without effective response. Conversely, strict separation can create gaps at interfaces where the practical object crosses institutional boundaries.

Mandates also possess provenance. The practical meaning of a mandate can depend on the reasons for which it was created, the conditions it presupposed, and the historical problems it was designed to address. A mandate formed under one technological, demographic, environmental, or institutional setting can become misaligned with a changed practical situation. Historical reconstruction can therefore be necessary before scope is interpreted as fixed.

Definition 10.416 (Mandate–capacity relation). A *mandate–capacity relation* is the practical correspondence between what an institution is authorized or expected to do and the capabilities, resources, knowledge, infrastructures, and interfaces through

which it can actually perform that mandate.

A strong mandate with weak capacity can create symbolic responsibility without effective agency. High capacity outside a recognized mandate can create action without adequate legitimacy or accountability. Practical design should therefore examine mandate and capacity together, while preserving their distinction. Expanding one does not automatically repair weakness in the other.

Mandates can also be revised. New problems can require delegation, shared jurisdiction, temporary authority, or new institutional forms. Such revision changes practical power and responsibility and should therefore remain traceable to explicit reasons, affected positions, limits, and review conditions.

Proposition 10.417 (Mandates and practical reach). *Institutional mandates organize the legitimate or recognized scope of praxis, while effective practical reach depends additionally on capacity, coordination, resources, knowledge, and the relational conditions through which authority can be exercised.*

10.15.2 Institutional Capacity

A mandate acquires practical significance only where an institution or collective can convert authority and intention into effective response. Institutional capacity therefore extends beyond possession of resources. It includes the ability to perceive relevant conditions, interpret them, form decisions, mobilize action, coordinate interfaces, maintain operations, monitor consequences, repair failure, learn, and revise prior commitments.

Definition 10.418 (Institutional capacity). *Institutional capacity* is the deployable ability of an institutional configuration to perform the sensing, interpretation, decision, implementation, coordination, maintenance, monitoring, repair, learning, and revision functions required by its practical objects under relevant conditions.

Capacity is therefore function-specific and situation-sensitive. An institution can possess strong analytical capacity and weak implementation capacity, strong emergency response and weak long-horizon maintenance, or extensive resources with limited ability to coordinate across boundaries. A single aggregate description can conceal these bottlenecks.

Definition 10.419 (Institutional capacity profile). *An institutional capacity profile* records the principal practical functions an institution or collective can perform, the conditions under which those functions are deployable, the bottlenecks among them, and the dependencies on external actors or infrastructures.

The distinction between nominal and deployable capacity is important. Expertise can exist without access to decision channels. Funds can exist without procurement authority. Data can exist without interpretive capability. Staff can exist without time or coordination. Infrastructure can exist without maintenance. Practical capacity therefore depends on conversion relations that connect possessed resources to usable action.

Definition 10.420 (Capacity conversion). *Capacity conversion* is the process through which resources, expertise, authority, infrastructure, information, relationships, and time become effectively deployable practical capability within a specific institutional configuration.

Capacity can also be overloaded. An institution may be capable under ordinary

conditions while losing effective function when case volume, urgency, uncertainty, coordination demand, or maintenance burden exceeds its operating range. Capacity assessment should therefore include reserve, redundancy, recovery, and surge conditions where the practical object is sensitive to overload.

Institutional capacity is partly collective. Coordination among several limited actors can generate a capability that none possesses alone. Shared infrastructure, common standards, complementary expertise, trusted referral pathways, or distributed observation can create emergent capacity. The reverse is also possible: individually capable actors can form a collectively weak system when interfaces are incompatible or authority is fragmented.

Capacity-building interventions consequently have generative effects. Training, infrastructure, records, interoperable systems, durable relationships, and learning routines can expand future action spaces. Capacity building can also create dependence when essential capability remains controlled by an external provider. Its relational and temporal structure therefore belongs to the practical assessment.

Proposition 10.421 (Capacity as an institutional relation). *Institutional capacity depends on the conversion of resources and authority through roles, interfaces, routines, infrastructures, and relationships, so increases in nominal resources do not by themselves establish corresponding increases in effective collective agency.*

10.15.3 Institutional Constraints

Institutions act within constraints generated by law, procedure, resources, infrastructure, knowledge, time, organizational history, public expectations, dependencies, and prior commitments. These constraints can reduce action space, slow response, or make some interventions inaccessible. They can also protect rights, preserve procedural quality, prevent concentration of power, maintain safety, or force deliberation before difficult-to-reverse commitments. Institutional constraints therefore require interpretation through their practical function rather than through a simple preference for fewer limits.

Definition 10.422 (Institutional constraint configuration). *An institutional constraint configuration is the structured set of legal, procedural, material, epistemic, temporal, infrastructural, relational, and historical conditions that limit, channel, sequence, or protect institutional action within a practical situation.*

Constraints differ in origin and revisability. Some are externally imposed. Others are internal rules adopted for reliability or accountability. Some derive from resource scarcity. Others arise from inherited infrastructure or technical standards. Some can be changed by the institution itself, while others require negotiation, higher authority, collective coordination, or long-term transformation.

A useful distinction concerns restrictive and enabling effects. A procedural review requirement can delay action while reducing error and improving accountability. Data-access restrictions can limit analysis while protecting privacy. Redundancy requirements can increase short-term cost while supporting resilience. Constraints should therefore be evaluated in relation to the practical objects and risks they organize.

Definition 10.423 (Enabling institutional constraint). *An enabling institutional constraint is a limitation or procedural condition that restricts some immediate actions*

while preserving or generating valued capabilities, protections, reliability, accountability, or future practical options.

Constraints can become misaligned. Rules designed for stable conditions can obstruct response under rapid change. Emergency exceptions can outlive the conditions that justified them. Historical routines can preserve categories that obscure new affected positions. Constraint revision should therefore examine both the value protected by the constraint and the consequences created by its present operation.

Institutional constraints also interact with power. Powerful actors can sometimes navigate procedures, absorb delay, acquire specialized expertise, or secure exemptions more easily than weaker actors. The same formal rule can therefore create different effective constraints across positions. A constraint profile should include such asymmetries where they materially affect participation, access, or burden distribution.

Proposition 10.424 (Institutional constraints and protected capability). *The practical significance of an institutional constraint depends on both the possibilities it restricts and the capabilities, rights, reliability, accountability, or future options it preserves or generates under the relevant conditions.*

10.15.4 Institutional Memory

Application-dominant praxis extends through time. Decisions are revisited by people who did not make them. Risks emerge after personnel change. Maintenance obligations persist beyond the initiating project. Institutional memory provides continuity across these temporal discontinuities. It can reside in records, archives, routines, categories, technical standards, infrastructures, professional practices, narratives, learned skills, or durable relationships.

Definition 10.425 (Institutional memory). *Institutional memory* is the distributed preservation of practically relevant knowledge, reasons, routines, skills, categories, records, relationships, and learned responses through which an institutional configuration carries experience across episodes and personnel changes.

Institutional memory has both explicit and tacit forms. Formal records can preserve decisions, assumptions, thresholds, dissent, incidents, responsibilities, and revision conditions. Tacit memory can persist through experienced personnel, professional judgment, routines, and informal networks. Each form has vulnerabilities. Formal records can become inaccessible or detached from context. Tacit memory can disappear quickly through turnover or fragmentation.

Definition 10.426 (Operational institutional memory). *Operational institutional memory* is the portion of institutional memory that remains sufficiently accessible, interpretable, and connected to present roles and procedures to influence current practical judgment or action.

The distinction between stored information and operational memory matters because extensive archives can coexist with recurrent forgetting. Retrieval, indexing, handoff, interpretive context, and responsibility for review determine whether preserved material enters future praxis. The provenance structures developed in Section 10.13 therefore support institutional memory only when later actors can use them.

Memory can also constrain. Institutions can overlearn from salient past events, re-

produce inherited categories, or treat earlier procedures as fixed because their original rationale has been forgotten. Memory should therefore preserve both prior conclusions and the conditions under which those conclusions were reached. Reasons, uncertainty, rejected alternatives, and reopening criteria are often as important as the final decision.

Definition 10.427 (Institutional memory handoff). An *institutional memory handoff* is a structured transfer of practically relevant records, reasons, unresolved uncertainties, responsibilities, skills, relationships, and revision conditions from one temporal or organizational configuration to another.

Memory is also selective. What an institution records reflects earlier problem formulations, measurement choices, power relations, and categories of recognition. Missing records can therefore reveal earlier exclusions as well as administrative failure. Institutional memory should remain open to supplementation by testimony, external archives, affected communities, and newly available evidence when the existing record is incomplete.

A strong memory architecture supports learning without making the past authoritative merely because it is preserved. Institutional learning requires comparison between inherited knowledge and changed conditions. Memory and revisability should therefore operate together.

Proposition 10.428 (Memory and revisable continuity). *Institutional memory supports responsible continuity when preserved experience remains accessible with sufficient provenance to inform present judgment while retaining the conditions for reinterpretation, supplementation, and revision under changed practical circumstances.*

10.15.5 Collective Decision

Collective praxis requires mechanisms through which differentiated judgments, roles, interests, knowledge, and authority become capable of organizing consequential commitment. A collective decision is therefore more than the sum of individual preferences. Its practical structure includes agenda formation, evidence selection, proposal generation, deliberation, aggregation or authorization, recording of dissent, implementation linkage, and conditions for reopening.

Definition 10.429 (Collective practical decision). A *collective practical decision* is a practically authoritative commitment produced through an organized process involving multiple differentiated positions whose inputs, rights, responsibilities, or dependencies materially contribute to the formation or execution of that commitment.

Different decision architectures can allocate these functions differently. One body can define the agenda, another provide technical analysis, another deliberate, another authorize, and still another implement. A collective decision can therefore emerge without a unified collective preference or a single moment at which all practical content is determined.

Definition 10.430 (Collective decision architecture). A *collective decision architecture* is the structured distribution of agenda-setting, evidence production, interpretation, proposal, deliberation, authorization, dissent recording, implementation linkage, monitoring, and reopening functions across the positions involved in a collective practical process.

This architecture connects directly to the power analysis of Section 10.11 and the

participation analysis of Section 10.12. Formal voting or authorization captures only one locus of decision power. Control over agenda, admissible evidence, timing, default options, amendment rules, and access to implementation can materially shape the resulting commitment.

Collective decisions can preserve disagreement. Requiring complete consensus can be impractical or can give disproportionate power to positions capable of withholding agreement. Majority procedures can suppress materially important minority concerns. Expert delegation can increase technical coherence while narrowing participatory standing. The appropriate architecture depends on the practical object, stakes, affected positions, uncertainty, reversibility, and need for continued cooperation.

Definition 10.431 (Decision dissent record). A *decision dissent record* is a traceable account of materially relevant objections, alternative interpretations, minority positions, unresolved uncertainties, and conditions under which those differences should be reconsidered after collective closure.

The record turns disagreement into institutional memory rather than treating closure as retrospective unanimity. It can later help distinguish unforeseen consequences from consequences that were anticipated but outweighed or insufficiently addressed.

Collective decision also requires connection to action. A formally valid commitment can remain practically inert when implementing actors lack capacity, incentives, authority, information, or ownership. Decision architecture should therefore include implementation interfaces and feedback channels rather than treating authorization as the terminal act.

Proposition 10.432 (Collective decision and distributed closure). *Collective practical closure can be achieved without complete agreement when the decision architecture makes authority, participation, dissent, implementation responsibility, residual uncertainty, and reopening conditions sufficiently explicit for coordinated action and later review.*

10.15.6 Coordination

Collective decisions do not by themselves align interdependent activity. Coordination concerns the practical organization of timing, information, interfaces, sequencing, standards, expectations, and role dependencies through which differentiated contributions become mutually compatible. Coordination can occur within a single institution or across organizations, communities, technical systems, and informal networks.

Definition 10.433 (Practical coordination). *Practical coordination* is the alignment of interdependent actions, information flows, timings, interfaces, and role expectations so that differentiated contributions can function together within a consequential practical process.

Coordination differs from cooperation. Actors can coordinate while pursuing partially conflicting ends, as when competitors follow shared safety protocols or institutions with different mandates exchange information. Cooperation can also exist without strong coordination, producing goodwill but duplicated effort, incompatible timing, or gaps in responsibility.

Definition 10.434 (Coordination architecture). A *coordination architecture* specifies the interfaces, information pathways, sequencing rules, shared standards, escalation

channels, synchronization mechanisms, and fallback procedures through which interdependent practical contributions are aligned.

Coordination burden can become substantial. Meetings, reporting, data translation, interoperability work, negotiation, handoff, and synchronization consume time and attention. Adding more actors can improve representation or capability while increasing these burdens. Effective coordination therefore depends partly on interface design and on identifying where standardization is useful and where local flexibility should be preserved.

Coordination failure often appears at boundaries. One institution can complete its assigned task while the collective process fails because a dependency was unspecified, a handoff occurred too late, or two systems interpreted the same category differently. These failures resemble the responsibility gaps developed in Section 10.13. They can be reduced by explicit interface ownership, shared situational awareness, and protocols for anomalies that do not fit routine categories.

Definition 10.435 (Coordination failure). A *coordination failure* is a breakdown in the alignment of interdependent roles, timings, information, standards, or interfaces that materially weakens collective practical performance even where individual components may remain locally functional.

Coordination should also remain adaptive. Highly standardized systems can perform efficiently under familiar conditions while responding poorly to novelty. Flexible local discretion can support adaptation but create inconsistency or obscure accountability. Coordination architectures therefore need a relation between routine operation and escalation into higher-order judgment when ordinary interfaces cease to fit the situation.

Proposition 10.436 (Coordination as interface capacity). *Where collective praxis depends on differentiated contributors, effective capacity depends materially on the quality of the interfaces among those contributors in addition to the competence or resources contained within each component.*

10.15.7 Cooperation

Coordination organizes interdependence, while cooperation concerns sustained contribution toward shared, compatible, or mutually supporting practical ends. Cooperation can be voluntary, role-based, reciprocal, contractually structured, normatively expected, or institutionally supported. Its practical importance lies in enabling actors to pool resources, distribute tasks, share risk, generate knowledge, and sustain undertakings that exceed individual capacity.

Definition 10.437 (Practical cooperation). *Practical cooperation* is a relational pattern in which differentiated actors contribute resources, capacities, knowledge, effort, or restraint in ways that mutually support one or more shared or compatible practical ends over a relevant period.

Cooperation does not require identical motivation. Participants can cooperate because of shared values, reciprocal advantage, duty, professional role, strategic interdependence, care, or long-term expectation. What matters is that their contributions become mutually enabling within the practical process.

Definition 10.438 (Cooperation condition profile). A *cooperation condition profile* records the principal dependencies, incentives, norms, trust relations, contribution

capacities, reciprocity expectations, monitoring arrangements, and exit conditions that sustain or weaken a cooperative practical relation.

Cooperation can generate surplus practical capacity. Shared learning can reduce duplication. Repeated interaction can improve coordination. Complementary expertise can make previously latent actions reachable. Joint infrastructure can reduce activation costs. These effects make cooperation a possible source of collective generativity.

Cooperation can also distribute benefits and burdens unevenly. Some participants can contribute invisible maintenance or care work while others receive more visible credit or decision authority. Some can bear the cost of flexibility when others miss commitments. Dependence on a highly capable partner can improve short-term performance while weakening autonomous capacity over time. The justice profile of cooperation therefore matters alongside its effectiveness.

Cooperative arrangements can also support harmful or exclusionary ends. Internal solidarity does not establish external justice. A tightly cooperative group can coordinate exploitation, exclusion, concealment, or burden transfer. Cooperation should consequently be evaluated in relation to the practical object, affected outsiders, accountability, and broader relational consequences.

Proposition 10.439 (Cooperation and collective capacity). *Cooperation can generate collective capabilities that exceed the isolated capacities of participants, while the justice and durability of those capabilities depend on how contributions, benefits, burdens, dependence, and accountability are organized within and beyond the cooperative relation.*

10.15.8 Conflict

Institutions and collectives contain heterogeneous values, interests, identities, interpretations, risk positions, responsibilities, and practical horizons. Conflict therefore belongs to ordinary collective praxis rather than representing only institutional breakdown. The relevant question is how conflict is formed, expressed, contained, interpreted, transformed, and connected to decision and revision.

Definition 10.440 (Practical conflict). *A practical conflict is a structured divergence among positions whose ends, values, interpretations, claims, burdens, authorities, identities, or preferred actions cannot be jointly realized without negotiation, priority, redistribution, transformation, or residual disagreement under the present practical conditions.*

Conflict can reveal information. Affected actors can perceive harms that central decision-makers do not observe. Technical disagreements can expose model uncertainty. Value conflict can reveal that an apparently common objective contains incompatible meanings. Institutional conflict can reveal overlapping mandates or missing responsibility. Suppressing conflict can therefore weaken the epistemic and adaptive capacity of the collective.

Definition 10.441 (Conflict architecture). *A conflict architecture is the set of channels, rules, protections, forums, escalation pathways, negotiation practices, and decision procedures through which materially relevant disagreement can enter collective praxis and influence its interpretation, closure, or revision.*

Conflict architecture connects to protected dissent in Section 10.12. The ability to

disagree safely can preserve early warning and prevent apparent consensus from concealing coercion or dependency. Yet continual contestation without closure can also disable action. Institutions require ways to distinguish disagreements that need further inquiry, those that require negotiated accommodation, those that can remain as recorded dissent after decision, and those that indicate a need to redesign the practical object itself.

Conflict can escalate. Repeated exclusion, opaque authority, distributive imbalance, identity threat, or failed repair can transform disagreement into antagonism. Conversely, new information, reframing, compensation, changed sequencing, shared problem reconstruction, or altered institutional roles can transform the structure of the conflict.

Definition 10.442 (Conflict transformation). *Conflict transformation* is a change in the relations, representations, incentives, capabilities, institutional interfaces, or practical objects through which a conflict is generated, such that the form or intensity of the conflict itself is altered.

Transformation differs from simple suppression. A conflict can become less visible because weaker actors lose voice while its generative conditions remain. Durable transformation requires attention to the relations through which the disagreement is reproduced.

Conflict also has an external dimension. Institutions can internalize cooperation while transferring costs or conflict outward to excluded groups, environments, or future actors. Collective analysis should therefore identify the boundary within which harmony is being observed.

Proposition 10.443 (Conflict as a source of collective information). *Where materially relevant disagreement reflects differences in evidence, affected position, value, burden, or practical horizon, preserving intelligible and protected conflict can increase the epistemic and adaptive capacity of collective praxis even when eventual closure remains necessary.*

10.15.9 Trust

Collective praxis depends on forms of reliance that cannot always be secured through complete verification. Actors rely on information they did not produce, procedures they cannot inspect in full, expertise they do not possess, commitments whose performance occurs later, and institutions whose continuity extends beyond particular persons. Trust therefore enters where practical interdependence combines reliance with vulnerability and incomplete control.

Definition 10.444 (Practical trust relation). *A practical trust relation* is a situated relation in which one position accepts material reliance on another actor, collective, institution, procedure, or system under conditions of vulnerability and incomplete verification because relevant expectations of competence, integrity, reliability, responsiveness, or rule-governed performance are sufficiently supported for the practical purpose.

Trust should be distinguished from mere dependence. A person can depend on an institution while expecting failure and lacking alternatives. Trust should also be distinguished from complete verification. Where every relevant action is fully controlled and checked, the practical role of trust is narrower. Most institutions operate

between these extremes, combining verification, standards, reputation, accountability, and trust.

Definition 10.445 (Institutional trust architecture). An *institutional trust architecture* is the set of roles, procedures, records, competence signals, accountability mechanisms, transparency conditions, contestability pathways, and repeated performance relations through which practical reliance on an institution becomes supportable or revisable.

Institutional trust can therefore attach to structures rather than only to personal familiarity. Reliable procedure, predictable escalation, accurate records, transparent reasons, independent review, and effective repair can support trust even when participants do not know one another personally. Conversely, a trusted individual operating within an opaque or fragile system may be unable to provide durable institutional trust.

Trust should be calibrated. Excessive distrust can increase verification burden, slow coordination, fragment information, and prevent cooperation. Excessive trust can reduce scrutiny, concentrate vulnerability, and delay recognition of failure. The appropriate level depends on stakes, history, reversibility, observability, alternative safeguards, and the cost of misplaced reliance.

Definition 10.446 (Trust calibration). *Trust calibration* is the alignment of practical reliance with the available evidence about competence, reliability, integrity, accountability, vulnerability, and repair capacity relevant to the specific institutional relation.

Trust also has temporal dynamics. Reliable performance can stabilize expectations. Breach can rapidly alter them. Repair requires more than renewed assurance where the institutional conditions that produced the failure remain unchanged. A credible repair process can require acknowledgment, explanation, remedy, changed procedure, monitoring, and demonstrated performance over time.

Trust is also unevenly distributed. Institutions may be highly trusted by positions that benefit from predictable treatment and weakly trusted by positions with histories of exclusion, error, or unremedied harm. Aggregated measures of trust can therefore conceal relational variation. A trust profile should remain position-sensitive and historically informed.

Proposition 10.447 (Trust and institutional reliance). *Institutional trust is practically stronger when reliance is supported by competence, traceable procedure, accountability, contestability, and repair capacity, because these conditions permit trust to remain both usable for coordination and revisable after failure.*

10.15.10 Collective Generativity

The preceding dimensions converge in the question of what institutions and collectives make possible later. Mandates open and close practical domains. Capacity makes actions reachable. Constraints protect or limit possibility. Memory preserves learning. Decision architectures organize closure. Coordination and cooperation combine differentiated capability. Conflict can reveal hidden conditions. Trust can support reliance across incomplete verification. Together these structures can generate future capacities that did not exist at the beginning of the practical process.

Definition 10.448 (Collective generativity). *Collective generativity* is the capacity of

an institutional or collective configuration to generate, sustain, combine, regenerate, or transform future practical capabilities, relationships, knowledge, coordination structures, trust conditions, institutions, and action possibilities beyond those directly consumed in the present intervention.

Collective generativity is not the sum of individual capability. A group can possess extensive individual expertise while lacking the interfaces needed to use it collectively. Conversely, modest individual capacities can produce substantial collective capability through complementary roles, shared memory, reliable coordination, mutual learning, and durable infrastructure. The relational organization of capability is therefore central.

Definition 10.449 (Collective generativity profile). A *collective generativity profile* records how a practical process changes future institutional and collective capacities for sensing, learning, deciding, coordinating, cooperating, contesting, repairing, revising, and generating new practical options across relevant positions and horizons.

Collective generativity can be enabling or constraining. Institutions can generate expertise, trust, rights, shared infrastructure, interoperable standards, public knowledge, and collective problem-solving capacity. They can also generate lock-in, dependence, opacity, brittle coordination, concentrated authority, exclusionary categories, and self-reinforcing inability to revise. Generativity therefore remains analytically distinct from normative desirability, consistent with the distinction established throughout the book.

Institutional reproduction is one form of generativity. Routines, training, archives, succession, budgets, and role structures allow practical capacity to persist. Yet reproduction can preserve both strengths and defects. A highly stable institution can become poorly adapted to a changed situation. Collective generativity should therefore include the capacity to transform the conditions of collective action, not merely to reproduce them.

Definition 10.450 (Institutional self-revision capacity). *Institutional self-revision capacity* is the practical ability of an institutional configuration to detect materially relevant mismatch, contest its existing arrangements, preserve usable memory, redesign roles or procedures, and implement changes to its own modes of action while maintaining sufficient continuity for responsible praxis.

Self-revision requires interfaces among research, monitoring, participation, evaluation, and decision. Institutions that cannot convert evidence of failure into changed practice can accumulate knowledge without learning. Institutions that revise continuously without preserving memory or responsibility can lose continuity. Generative institutional design therefore requires a relation between stability and transformability.

Collective generativity also has distributive structure. An institution can increase aggregate capability while concentrating access to essential data, infrastructure, expertise, or decision rights. It can generate new possibilities for one group while narrowing exit or independent capacity for another. The generative opportunity and justice profiles developed in Section 10.14 therefore remain necessary at the institutional level.

Proposition 10.451 (Collective generativity and institutional form). *The long-horizon practical significance of an institutional or collective arrangement includes the capabilities, relationships, knowledge, trust conditions, coordination structures, and revision*

capacities that it generates or erodes for later praxis, in addition to the immediate outputs of the present action.

Taken together, these dimensions make institutional and collective praxis a durable medium for application-dominant praxis. Their interactions also make application a source of knowledge: implementation produces traces, coordination exposes interfaces, conflict reveals divergent interpretations, failure generates diagnostic evidence, and revision changes the conditions for later inquiry. Section 10.16 develops this reciprocal coupling between application and research.

10.16 Coupling between Application and Research

Sections 10.1–10.15 have developed application-dominant praxis as a configuration in which consequential action becomes practically determinative while knowledge, values, authority, timing, and future consequences remain partly open. The role of the present section is to reconnect that architecture to the research-dominant praxis developed in Part III without returning to a linear model in which research first produces completed knowledge and application subsequently implements it. Its objective is to specify the reciprocal pathways through which research informs action, action generates evidence, interventions carry epistemic functions, practical failure reorganizes inquiry, theory changes through use, and post-action experience becomes available for disciplined re-epistemization. The discussion proceeds through seven movements: research-informed action, action-generated evidence, intervention as inquiry, practical failure as epistemic event, theory revision through practice, re-epistemization after action, and return toward research-dominant praxis. The method is architectural and recursive. Research and application remain analytically distinguishable praxis modes while their outputs, responsibilities, records, and transformations are traced across repeated crossings between them.

The recursion also requires a typed distinction between observation and transformation. A readout can update a representation without changing the modeled configuration, while an epistemic event can be performatively coupled to a later state-changing operation through recognition, classification, communication, institutional uptake, or intervention. Application-generated evidence can therefore alter both what is known and the field from which later evidence is generated.

A reciprocal account is necessary because application changes the object about which later research asks questions. A decision can alter institutions, expectations, relations, categories, capabilities, incentives, infrastructures, and available options. Monitoring after action therefore occurs in a historically transformed field. At the same time, research does not enter application as a neutral stock of facts. Its questions, boundaries, models, uncertainty profiles, and closure records acquire new functions once they participate in consequential judgment. The relevant relation is consequently neither simple transfer nor complete fusion. It is a coupling in which the two praxis modes remain differentiated while each can reorganize the conditions under which the other proceeds.

Definition 10.452 (Research–application coupling). *Research–application coupling* is the structured and revisable relation through which research objects, evidential states, models, uncertainties, practical actions, implementation traces, consequences, and institutional learning travel between research-dominant and application-

Table 10.16: Principal movements in the coupling between application and research

Movement	Principal practical object	Epistemic function	Characteristic discipline
Research-informed action	Research claims, models, historical reconstructions, uncertainty and robustness profiles	Supplies structured warrant and alternatives for practical judgment	Function-sensitive transfer and explicit limits of use
Action-generated evidence	Implementation traces, responses, adaptations, unintended effects, emergent relations	Reveals or constitutes relations, mechanisms, capacities, constraints, and consequences	Intervention provenance and distinction between revelation and generation
Intervention as inquiry	Deliberate or adaptive practical change	Uses action to discriminate mechanisms, test assumptions, or expose practical structure	Dual practical–epistemic governance and consequence-sensitive inquiry
Failure as epistemic event	Breakdown, mismatch, unmet end, harm, resistance, or implementation divergence	Creates diagnostic pressure on models, categories, assumptions, and practical design	Failure decomposition, attribution restraint, and preservation of negative evidence
Theory revision through practice	Conceptual and theoretical architectures used in application	Tests transport, scope, mechanism, category adequacy, and omitted relations	Versioned theory revision and preservation of superseded states
Post-action re-epistemization	Preserved decisions, traces, outcomes, dissent, uncertainty, and later knowledge	Reconstructs earlier action under changed evidence, concepts, methods, or historical conditions	Temporal separation of earlier warrant from later interpretation
Praxis-mode return	Reopened questions, unresolved anomalies, changed objects, new evidential demands	Reorganizes the project around inquiry when knowledge production again becomes principal	Explicit transition record and renewed research closure conditions

dominant praxis while retaining sufficient provenance to reconstruct changes in their function and epistemic status.

Definition 10.452 emphasizes function and provenance. A model used to explore a mechanism in research can later become a decision aid. An implementation record generated for accountability can later become evidence. A practical failure can become a new research question. The object may remain materially continuous while its role changes. The coupling architecture should make such functional changes visible so that epistemic status established for one purpose is not silently transferred to another.

Table 10.16 summarizes the seven principal movements developed in this section. The table is intentionally directional in both ways. Some movements carry research into action, some carry action back into inquiry, and several operate across the boundary in both directions.

The table also indicates why coupling should remain governed. Application can produce large volumes of data without producing useful evidence. Research can supply highly refined models whose operational function exceeds their warrant. Failure can provoke learning or merely produce retrospective storytelling. Re-epistemization can deepen understanding or project later categories backward without discipline. The coupling becomes epistemically productive when each transition records the object being transferred, the function it is asked to perform, the uncertainties that remain, and the conditions under which its status should be reconsidered.

10.16.1 Research-Informed Action

Research-informed action is the first direction of coupling because application-dominant praxis rarely begins from an epistemic blank state. Historical reconstruc-

tion, field knowledge, empirical evidence, models, scenarios, interpretations, prior interventions, negative results, and uncertainty analyses can all shape practical judgment. Their role is to discipline attention, make alternatives visible, clarify plausible mechanisms, identify affected relations, and narrow unsupported claims. Their presence does not determine action by themselves because practical judgment also includes values, authority, risk, participation, timing, reversibility, and responsibility.

Definition 10.453 (Research-informed action). *Research-informed action* is consequential praxis whose problem formulation, judgment, end specification, option construction, timing, implementation, monitoring, or revision is materially shaped by research objects whose evidential status, scope, uncertainty, and provenance remain identifiable at the point of practical use.

The definition requires more than citation to research. A practical decision can invoke a study rhetorically while ignoring its scope conditions or uncertainty. Conversely, tacit institutional knowledge can be research-informed when it is linked to preserved inquiry and can be reconstructed. The relevant question is whether research changes the practical architecture in a traceable way.

The carry-forward state established in Chapter 9, Section 264, supplies several kinds of research object. Relational reconstructions can identify positions and dependencies. Generative models can suggest mechanisms and trajectories. Sensitivity analysis can identify assumptions whose alteration changes a conclusion. Robustness analysis can reveal which practical interpretations survive across plausible alternatives. Historical inquiry can show how a present condition was formed. Negative results can remove apparently attractive but unsupported pathways. Closure records can identify what the completed research cycle established and what remained unresolved.

These objects acquire different burdens in application. A model used to generate a research hypothesis can be useful in practical brainstorming without being sufficiently validated for direct operational control. A descriptive classification can become consequential when eligibility, access, or burden is attached to it. A weakly supported mechanism can still justify additional monitoring while remaining insufficient to justify an irreversible intervention. The transfer from research to application therefore requires a function-sensitive translation.

Definition 10.454 (Practical research-use profile). A *practical research-use profile* records the research object being used, its original research function, its proposed practical function, evidential and model status, scope conditions, material uncertainties, relevant alternatives, practical consequences of error, and any additional validation or governance required by the change of use.

The profile prevents epistemic status from travelling by association. Research sufficiency established for publication, conceptual development, or exploratory modeling does not automatically establish sufficiency for high-stakes application. This principle parallels the action-relative epistemic sufficiency developed in Section 10.8. The practical function helps determine the burden.

Research can also inform action through disagreement rather than convergence. Competing models can reveal different vulnerability structures. Divergent qualitative and quantitative findings can identify scale or category problems. Historical interpretation can challenge assumptions built into a current optimization. A preserved minority interpretation can become practically salient when an intervention reaches

the population or context about which that interpretation was concerned. Research-informed action therefore does not require the research record to have collapsed into one conclusion.

The relation also remains selective. Practical decisions operate under temporal and institutional constraints. Decision makers can rarely reconstruct the complete lineage of every research object during action. Good coupling therefore depends on intermediary forms that preserve material epistemic distinctions without reproducing the entire research archive. These can include uncertainty summaries, model cards, scenario dossiers, causal maps, historical briefs, closure records, or decision-specific evidence syntheses, provided their compression remains linked to fuller provenance.

Proposition 10.455 (Function-sensitive research transfer). *Research contributes more responsibly to application when the warrant attached to a research object is assessed afresh relative to its practical function, consequence profile, scope, uncertainty, and alternatives, with the original research function retained as provenance rather than transferred as sufficient warrant.*

Research-informed action therefore preserves a distinction between being informed by research and being determined by research. The former strengthens practical judgment by making its epistemic dependencies more inspectable. The latter would erase the normative, relational, institutional, and temporal dimensions established throughout Chapter 10.

10.16.2 Action-Generated Evidence

Application produces traces that did not exist before action. Chapter 8, Section 231, developed action-generated evidence within research-dominant generative inquiry and defined it as evidence whose observability, diagnostic value, or existence depends materially on intervention. The present subsection changes the orientation. The practical action is now principally organized around consequential purposes, while its implementation and consequences can nevertheless become epistemically informative. The objective is to specify how those traces can return to inquiry without treating every operational datum as research evidence.

Implementation can reveal latent constraints. A policy can encounter an institutional bottleneck not visible in planning. A service can reveal previously unrecognized demand. A new coordination channel can expose dependence between organizations. An infrastructure change can generate behavioral adaptation. A protective measure can show that an assumed mechanism was weaker or stronger than expected. Resistance, workaround, non-use, refusal, maintenance difficulty, and unexpected uptake can all become evidence about the relational configuration within which the action operates.

The distinction between revelation and constitution remains essential. An action can reveal an existing relation, create a new relation, activate a latent capacity, suppress a prior pathway, or transform the categories through which later behavior is organized. Evidence after action therefore cannot be interpreted as though it were drawn from an unchanged field.

Definition 10.456 (Application-generated evidential trace). *An application-generated evidential trace is an observation, record, response, adaptation, outcome, or emergent relation produced or made observable through application-dominant praxis that can bear on a later epistemic question when its dependence on the practical intervention*

is preserved.

The term *trace* is used deliberately. A trace becomes evidence only relative to a claim and inferential architecture. Operational systems generate logs, reports, complaints, performance indicators, financial records, sensor data, narratives, meeting minutes, and administrative classifications. Their existence does not guarantee evidential adequacy. They can be incomplete, strategically produced, shaped by reporting incentives, or restricted to what institutions already know how to measure. Their conversion into evidence therefore requires renewed question formation and provenance assessment.

Definition 10.457 (Action-to-evidence conversion). *Action-to-evidence conversion* is the disciplined process through which application-generated traces are connected to a specified epistemic question, evaluated for provenance and representational limits, compared with relevant alternatives, and assigned an evidential status appropriate to the claim they can support.

This conversion prevents monitoring from being equated with research. Monitoring often asks whether implementation remains within a practical range or whether a trigger for revision has occurred. Research can ask why the observed pattern emerged, whether a mechanism generalizes, how effects differ across positions, or which generative rule changed. The same trace can participate in both functions, yet the inferential burden differs.

Action-generated evidence can also be highly selective because practical systems observe what they operationalize. A programme designed around one target can produce rich data about that target while remaining almost silent about unrecognized burdens. A digital platform can record interactions that occur within it while obscuring excluded users or off-platform adaptation. An institutional complaint system can document voiced harm while missing positions unable or unwilling to complain. The epistemic return from application therefore depends partly on the participation, recognition, and measurement architectures developed in Sections 10.12 and 10.11.

Unintended consequences are especially important because they can reveal branches outside the planned theory of action. Their evidential value increases when timing, pathway, affected positions, competing explanations, and intervention dependence can be reconstructed. A surprising outcome alone does not identify its cause. Yet repeated or patterned surprises can indicate that the practical model omits a relation, mis-specifies a scale, or assumes a stability that the intervention itself has changed.

Proposition 10.458 (Application evidence with intervention provenance). *Traces generated during application become stronger inputs to later research when the records preserve what action occurred, under which conditions, for whom, through which implementation pathway, with which adaptations, and against which plausible alternative explanations.*

Application-generated evidence therefore turns practical history into a possible epistemic resource while retaining the historicity of that resource. Later inquiry studies a world partly transformed by earlier action.

10.16.3 Intervention as Inquiry

Application can contain inquiry even when practical transformation remains the dominant orientation. A staged intervention can be designed to preserve learning. A pilot can compare implementation pathways. A phased rollout can reveal capacity differences. Adaptive action can change in response to accumulating evidence. A reversible intervention can be selected partly because it enables diagnostic observation before deeper commitment. These arrangements make inquiry an embedded function of application rather than the principal purpose of the entire praxis configuration.

Definition 10.459 (Inquiry-bearing intervention). An *inquiry-bearing intervention* is an application-dominant action whose design, sequencing, monitoring, or variation intentionally preserves opportunities to learn about mechanisms, implementation conditions, affected relations, consequences, or future action possibilities while the principal orientation remains practical transformation.

The distinction from intervention-based research is one of organizing function. In research-dominant inquiry, the intervention is principally justified by the epistemic problem, subject to practical and ethical constraints. In application-dominant praxis, the intervention is principally justified by the practical problem, while learning is designed into the action because uncertainty remains and later judgment can improve. The same technical design can move between these orientations as conditions change.

Inquiry-bearing intervention can take several forms. Staging can expose effects before scale expands. Modularity can isolate components whose interactions remain uncertain. Parallel local implementations can reveal contextual dependence. Deliberate variation can distinguish among practical pathways when several are already acceptable. Monitoring can be structured around mechanism-relevant signals rather than only terminal outcomes. Reversible commitments can preserve an opportunity to learn without making early uncertainty historically permanent.

The epistemic advantages remain bounded by justice and responsibility. Application cannot treat affected subjects merely as experimental material because the practical action already carries obligations established in Sections 10.12–10.14. Learning value does not independently authorize exposure. Where deliberate variation redistributes risk, benefit, access, or burden, that variation requires practical justification in addition to epistemic usefulness.

Definition 10.460 (Practical learning architecture). A *practical learning architecture* specifies which uncertainties an intervention is expected to reduce, which observations are needed, how implementation variation will be interpreted, which actors can access and contest the resulting evidence, how learning can alter ongoing action, and which practical protections bound the inquiry function.

This architecture should include the possibility that action changes the question. An intervention can reveal that the original endpoint was poorly chosen, that affected subjects value a different condition, that implementation produces a new dependency, or that the practical problem has shifted. Inquiry within application is therefore not limited to parameter estimation inside a fixed model. It can reopen categories, boundaries, ends, and the object of action itself.

The capacity to learn during action also depends on institutional design. Section 10.15 developed memory, coordination, conflict, trust, and self-revision as collective capacities. Without those interfaces, organizations can collect evidence

without converting it into changed practice. An inquiry-bearing intervention consequently requires both an observation pathway and a decision pathway through which materially relevant learning can modify what happens next.

Proposition 10.461 (Embedded inquiry under practical primacy). *Application-dominant praxis can contain substantial inquiry without changing praxis mode when learning remains organized around the responsible conduct, monitoring, revision, or evaluation of consequential action rather than becoming the principal purpose for which the practical configuration is maintained.*

The proposition preserves the distinction between modes while making their overlap substantive. Application need not wait for research to finish because it can create its own governed learning structures. Research need not absorb all inquiry because some epistemic functions properly remain embedded within practical institutions.

10.16.4 Practical Failure as Epistemic Event

Practical failure can create strong pressure for epistemic revision because it exposes a mismatch between an intended practical architecture and the trajectory that actually emerged. Failure can concern an end that was not achieved, an implementation that broke down, an unforeseen burden, a harmful branch, a coordination interface, an assumption about behavior, an institutional incapacity, or a practical action that became unacceptable as consequences accumulated. The role of the present subsection is to make such failure epistemically usable without equating failure with simple falsification of the theory that informed action.

Definition 10.462 (Practical failure event). *A practical failure event is a materially consequential divergence between the warranted expectations, requirements, safeguards, or ends organizing an intervention and the observed practical trajectory, where the divergence is sufficient to require explanation, response, or revision.*

Failure is relative to the practical architecture. An intervention can achieve its nominal target while failing distributively because burdens are concentrated unexpectedly. It can succeed initially while failing at maintenance. It can satisfy an institutional indicator while generating relational harm. It can fail according to one value while remaining acceptable according to another. A failure record should therefore preserve which expectation or requirement was violated rather than assigning a global label to the entire action.

Several sources of failure should be distinguished. The underlying theory can be wrong or incomplete. The problem formulation can omit an affected relation. The intervention can be poorly implemented. Resources or authority can be insufficient. External conditions can change. Strategic actors can adapt. Measurement can misclassify outcomes. The selected end can become normatively inadequate. Coordination can break at an interface. A theory can remain locally sound while the institutional conditions required for its practical use were absent.

Definition 10.463 (Failure decomposition). *Failure decomposition is the reconstruction of a practical failure across potentially distinct loci including problem formulation, evidence, model, theory, value judgment, option design, authority, implementation, coordination, measurement, external change, adaptation, maintenance, and evaluation.*

Decomposition does not imply that each failure has one isolable cause. Several

loci can interact. A model can omit strategic adaptation while an institution simultaneously lacks the capacity to detect it. A poorly specified target can encourage implementation behavior that satisfies the indicator while worsening the underlying condition. The objective is to make competing failure accounts inspectable enough to guide both repair and inquiry.

Failure can therefore function as an epistemic event. It can expose a hidden constraint, reveal that an assumed relation was unstable, show that a category lacks practical correspondence, identify a missing scale, or reveal that actors interpreted the intervention differently than the model assumed. Failure can also expose limits of research transfer: a finding can be valid in its original context yet transport poorly into a new institutional configuration.

Definition 10.464 (Failure-generated epistemic question). *A failure-generated epistemic question is a researchable uncertainty whose practical significance becomes salient because an intervention diverged materially from its expected or required trajectory and whose resolution could alter explanation, redesign, scope, or future practical judgment.*

Negative evidence should be preserved even when immediate repair succeeds. Institutions often have incentives to narrate recovery as restoration of competence and to compress the history that made repair necessary. Yet a preserved failure can later reveal recurring structural weakness, inform analogous contexts, or become newly interpretable under later theory. This is one reason the responsibility and institutional-memory architectures of Sections 10.13 and 10.15 are epistemically consequential.

A failure also need not imply that continued application should stop while research proceeds. Urgency, reversibility, protective duties, and available alternatives can justify immediate redesign under uncertainty. The practical and epistemic responses can therefore run in parallel: stabilize harm, preserve evidence, revise implementation, and initiate deeper inquiry where necessary.

Caution 10.465 (Failure attribution). A practical failure should not be treated as direct evidence against a theory, model, institution, or actor until the relation among design, implementation, context, adaptation, measurement, and the failed practical requirement has been reconstructed with sufficient specificity for that attribution.

Proposition 10.466 (Failure as epistemic opening). *Practical failure becomes epistemically productive when its divergence is preserved with sufficient provenance to generate discriminating questions about the assumptions, relations, mechanisms, values, and institutional conditions through which the practical trajectory was expected to unfold.*

Failure therefore creates an opening rather than an automatic conclusion. The next movement concerns how such openings can alter theory itself.

10.16.5 Theory Revision through Practice

Application subjects theory to conditions that differ from those under which a theory can appear coherent within research. Concepts must be interpreted by institutions. Models encounter incomplete implementation. Actors adapt to classifications. Boundaries acquire practical consequences. Temporal delays matter. Values enter operational rules. The theory's categories can become performative once institutions act through them. Practice can therefore test not only empirical predictions but also

the transportability, operational intelligibility, and institutional consequences of theoretical structures.

Definition 10.467 (Practice-induced theory pressure). *Practice-induced theory pressure* is a materially relevant mismatch, anomaly, translation difficulty, unintended consequence, or recurrent implementation pattern generated through practical use that provides reason to reconsider the content, scope, representation, or status of a theory or one of its components.

Theory pressure can remain local. A parameter can require revision while the mechanism remains useful. A mechanism can remain valid only under narrower institutional conditions. A category can need differentiation. A scale assumption can fail while the underlying relation survives. A theory can retain explanatory value but lose suitability for direct practical guidance. The revision should therefore match the location of the pressure rather than treating every practical anomaly as a reason for wholesale theoretical replacement.

Practice can also expose conceptual ambiguity. Terms that remain productive in theoretical discussion may become unstable when translated into eligibility rules, measurement systems, organizational roles, or decision thresholds. Operationalization can force distinctions that research had left tacit. Such practical pressure can improve theory when the resulting distinctions are brought back into conceptual analysis rather than treated merely as implementation details.

Definition 10.468 (Practice-to-theory revision record). A *practice-to-theory revision record* identifies the practical event or pattern creating revision pressure, the theoretical object affected, the proposed depth of revision, supporting and countervailing evidence, preserved alternatives, consequences for earlier claims, and conditions under which the revised formulation should be re-evaluated.

The record should preserve superseded theory states when they remain relevant to historical reconstruction. An earlier theory may have shaped the intervention that produced the evidence now used to revise it. Erasing the earlier state would obscure the causal and epistemic lineage. Versioned theory therefore supports both responsibility and future re-epistemization.

Theory revision through practice also requires restraint because practical outcomes are mediated by implementation and context. A theory used through a weak institution can appear empirically poor because its required conditions were absent. Conversely, a practically successful intervention can receive support from mechanisms different from those the theory proposed. Practical success alone does not confirm the theory that motivated action.

Proposition 10.469 (Practice-sensitive theory revision). *Practice warrants theory revision most strongly when the practical record can distinguish pressure on the theory's conceptual or generative structure from pressure arising principally through implementation failure, contextual difference, measurement error, institutional incapacity, or changed practical ends.*

The relation remains reciprocal. Theory helps organize what practice observes, while practice can reorganize the theory through which later situations become intelligible. This reciprocity motivates post-action re-epistemization.

10.16.6 Re-Epistemization after Action

Re-epistemization after action concerns the disciplined reconstruction of an earlier practical episode under later epistemic conditions. Part III developed historical re-epistemization for research objects, archives, models, categories, and completed research cycles. Application adds another layer because later inquiry must reconstruct what actors knew, believed, valued, could do, and could reasonably foresee before the consequences were fully manifest. The objective is to learn from later evidence without rewriting the earlier decision as though later knowledge had already been available.

Definition 10.470 (Post-action re-epistemization). *Post-action re-epistemization* is the disciplined reconstruction of a prior practical situation, judgment, decision, implementation, and consequence under later evidence, concepts, methods, or historical knowledge while preserving the earlier information state, uncertainty, alternatives, authority, and practical constraints needed to distinguish later interpretation from contemporaneous warrant.

This distinction between *as-of* and later knowledge is essential. A later harmful consequence can reveal that an intervention should now be changed without proving that the original decision was negligent. Conversely, an action can have produced a favorable outcome despite weak original warrant. Outcome and decision quality are related but not identical. Re-epistemization should preserve both the *ex ante* and *ex post* structures.

The required record is broader than an ordinary evaluation file. It can include the original problem formulation, evidence state, research-use profiles, uncertainty, dissent, practical ends, option set, decision threshold, expected consequences, responsibility allocation, implementation adaptations, monitoring signals, failure events, repairs, and later outcomes. The provenance chain developed in Section 10.13 supplies much of this architecture.

Definition 10.471 (Practical as-of state). A *practical as-of state* is a reconstruction of the materially relevant knowledge, uncertainty, values, options, authority, capacities, constraints, and foreseeable consequence structure available to the responsible positions at a specified point in an earlier practical process.

Re-epistemization can operate at several depths. A local reanalysis can update one causal estimate. A category revision can change how earlier records are interpreted. New testimony can reveal affected positions omitted from the original problem. A later comparison can show that an institutional effect previously attributed to the intervention depended on a broader historical change. A new formal model can reconstruct feedback that earlier analysis could not represent. These later resources can transform understanding while leaving the earlier temporal record intact.

Practical records also preserve negative epistemic option value. A failed pilot, abandoned design, minority dissent, or unresolved anomaly can become highly informative under a later question. Deleting such records because they did not support the final action weakens future learning. Preservation remains bounded, however, by privacy, legitimate confidentiality, security, stewardship, and the burden of maintaining records that no longer serve a proportionate purpose.

Definition 10.472 (Re-epistemization dossier). A *re-epistemization dossier* is a versioned collection linking an earlier practical as-of state and intervention history with later evidence, consequences, uncertainty, revised interpretations, and reasons for

changed judgment.

Re-epistemization is also relevant to justice. Later recognition of an affected group, historical burden, or value that was insufficiently represented can alter the interpretation of an earlier practical process. The later judgment should state whether the issue was reasonably inaccessible at the time, weakly visible but ignored, actively excluded, or visible through a dissent that the institution overrode. These differences matter for institutional learning and accountability.

Proposition 10.473 (Temporal discipline in post-action learning). *Post-action learning is strengthened when later evidence can revise the interpretation and future use of an earlier decision without collapsing the distinction between what is known now and what was reasonably available to the responsible actors at the time of action.*

Post-action re-epistemization therefore converts practical history into a revisable epistemic object. In some cases the resulting questions become sufficiently central that the praxis configuration should shift back toward research-dominant orientation.

10.16.7 Research-Dominant Praxis Recoupling

Application-dominant praxis can return toward research-dominant praxis when an epistemic problem becomes sufficiently consequential and insufficiently resolved that the production and revision of warranted knowledge again becomes the principal organizing function of a phase. This return is not regression to a prior stage. The field has changed through action, new evidence exists, responsibilities have accumulated, and some options may have been generated or foreclosed. The research phase begins from an altered practical history.

Signals for return include unresolved mechanisms after failure, consequential competing explanations, model breakdown outside the original context, contested categories, poorly understood institutions generated by intervention, long-horizon effects, and repeated adaptation that weakens the original theory of change. Such developments can make systematic inquiry more appropriate than continued local adjustment.

Definition 10.474 (Research-return trigger). *A research-return trigger is a practical, evidential, theoretical, historical, or governance development indicating that a materially important uncertainty can no longer be addressed adequately within the embedded learning functions of application and should become the principal object of renewed research-dominant praxis.*

The trigger should be proportional. Local monitoring, expert review, or implementation adjustment can resolve many uncertainties. A stronger transition becomes appropriate when the unresolved question materially affects legitimacy, effectiveness, safety, justice, or future generativity and systematic inquiry can plausibly improve the practical situation.

The return also requires a boundary decision about ongoing action. Some interventions can pause while research proceeds. Others concern essential services, urgent protection, or durable institutional functions that cannot simply be suspended. Research-dominant inquiry can therefore occur alongside continued application-dominant operations. The two modes can become nested: the broader institution remains application-dominant while a defined subsystem, evaluation unit, or re-

search collaboration becomes research-dominant around a specific question.

Definition 10.475 (Praxis recoupling record). *A praxis recoupling record identifies the practical development prompting renewed inquiry, the research question being reopened or newly formed, the application functions that continue during research, the evidential and ethical interfaces between the two modes, the responsible actors, and the conditions under which the research phase can later return its outputs to practical judgment.*

The record closes the loop opened by the praxis transition interface established in Chapter 9, Section 264. Research outputs can enter application through a documented change of function; application can then generate evidence, failure, theory pressure, and new questions that reorganize part of the praxis configuration around research. The resulting movement is recursive and historical because each return begins from an altered field.

Application institutions should retain sufficient epistemic capacity to monitor and revise their own action. Some questions, however, require longer horizons, alternative methods, deeper evidence, independent critique, or distance from immediate operational demands. A return toward research-dominant praxis creates room for those functions while application continues to learn.

Proposition 10.476 (Recursive transition between praxis modes). *The two praxis modes can alternate, overlap, and nest across practical history. Each transition should follow a change in the principal organizing problem and preserve material outputs, uncertainties, responsibilities, and inherited field changes.*

The coupling developed across this section completes an important part of the Chapter 10 architecture. Research can inform action; action can generate evidence; intervention can preserve inquiry functions; failure can open epistemic questions; theory can change under practical pressure; later inquiry can re-epistemize action; and application can return toward research when knowledge production again becomes practically determinative.

This reciprocal architecture also prepares the chapter's penultimate problem. Even with research–application coupling, praxis cannot remain indefinitely open. Decisions, implementations, evaluations, and institutional processes eventually require a provisional stopping point sufficient for coordinated action and responsibility. Section 10.17 therefore turns to *Practical Closure*: the conditions under which application-dominant praxis can close provisionally while preserving residual uncertainty, residual disagreement, revision, reversal, exit, and the possibility of reopening deliberation.

10.17 Practical Closure

Sections 10.1–10.16 have developed application-dominant praxis as a configuration in which consequential action must be organized through incomplete knowledge, plural values, unequal power, distributed agency, institutional mediation, and historically changing practical fields. The role of the present section is to specify how such praxis can reach a bounded stopping point sufficient for coordinated action and responsibility without representing the underlying uncertainty, disagreement, or relational dynamics as finally resolved. Its objective is to develop a theory of *practical closure* that can support commitment while preserving the epistemic, normative, institutional,

and temporal conditions required for later revision. The discussion proceeds through nine movements: necessity of closure, decision before complete knowledge, provisional practical closure, residual uncertainty, residual disagreement, conditions for revision, conditions for reversal, conditions for exit, and reopening deliberation. The method is architectural and temporal. Closure is analyzed as a structured practical state situated between open deliberation and later change rather than as the terminal elimination of doubt.

Application-dominant praxis requires closure because action, coordination, allocation of responsibility, and institutional continuity cannot remain indefinitely suspended. Yet the need to close does not convert partial knowledge into complete knowledge, plural judgment into unanimity, or practical authorization into final correctness. Closure therefore performs a specific function: it stabilizes enough of the practical configuration for a defined commitment, horizon, scale, and responsibility architecture to operate. The resulting stability is real, but bounded.

Definition 10.477 (Practical closure). *Practical closure* is a temporally and functionally bounded stabilization of problem formulation, practical judgment, authorized commitment, responsibility, and implementation conditions sufficient for coordinated praxis under a specified horizon while materially relevant uncertainty, disagreement, revision pathways, and later consequences remain explicitly preservable.

Definition 10.477 distinguishes closure from finality. A practical process can close sufficiently for action while remaining epistemically incomplete, normatively contested, institutionally revisable, and historically open. The object being closed can also differ. A decision can close while evaluation remains open. A pilot can close its enrollment phase while the broader intervention remains provisional. A regulatory process can close one authorization question while monitoring obligations continue. A collective can close deliberation for the present cycle while preserving a scheduled review. Practical closure should therefore identify *what* is being stabilized and for which function.

Table 10.17 summarizes the principal dimensions of closure developed in this section. The table emphasizes that each closing operation should carry forward some remainder or reopening pathway. A closure architecture that records only the authorized action can erase the very conditions that made the authorization provisional.

The architecture is intentionally asymmetric. Closure may occur quickly while reopening can require substantial institutional work. Implementation can deepen path dependence while review capacity erodes. Records can disappear, personnel can change, and dissent can become difficult to reconstruct. For this reason, reopening capacity should be designed at the time of closure where consequences and uncertainty make later correction materially important.

Proposition 10.478 (Closure without finality). *Application-dominant praxis can achieve a practically sufficient stopping point without treating the underlying epistemic, normative, relational, or historical field as finally settled when the closure object, authority, horizon, residual uncertainty, residual disagreement, responsibility, and pathways for later change remain materially explicit.*

Proposition 10.478 supplies the integrating principle for the section. Practical closure is strongest when its boundaries are intelligible: actors know what has been decided, what remains uncertain, who is responsible for implementation and monitoring, which disagreements remain active, what would justify reconsideration, and

Table 10.17: Principal dimensions of practical closure

Dimension	Primary practical object	Closure function	Preserved condition
Necessity of closure	Open inquiry, deliberation, coordination, and commitment	Establishes a bounded stopping point for action and responsibility	Explicit object, horizon, authority, and consequence of delay
Decision before complete knowledge	Evidence, models, uncertainty, and practical thresholds	Converts sufficient warrant into authorized commitment without claiming completeness	Residual uncertainty and assumptions linked to monitoring
Provisional closure	Decision, implementation, responsibility, and review architecture	Stabilizes a practical configuration for a specified purpose and duration	Scope, duration, revision authority, and reopening conditions
Residual uncertainty	Unresolved mechanisms, boundaries, consequences, and affected positions	Keeps uncertainty visible after closure	Uncertainty profile, detection pathway, contingency, and responsible monitor
Residual disagreement	Divergent evidence judgments, values, priorities, and interpretations	Preserves materially relevant dissent after authorized commitment	Grounds of disagreement, standing, and later review pathway
Revision	Existing decision or orientation	Permits modification when practical warrant materially changes	Revision triggers, authority, memory, and implementation capacity
Reversal	Implemented action and its consequences	Enables rollback, restoration, repair, or redirection where feasible	Reversibility profile, rollback capacity, and residual harm record
Exit	Actor–arrangement relation	Permits termination or relocation of participation under specified conditions	Exit capacity, transition obligations, and exit remainder
Reopening	Closed deliberative configuration	Restores previously stabilized questions to active collective judgment	Trigger, standing, provenance, procedural pathway, and new closure criteria

which consequences may resist correction.

10.17.1 Necessity of Closure

Application-dominant praxis eventually encounters a coordination problem that inquiry alone cannot resolve. Evidence can continue to accumulate, interpretations can continue to multiply, values can continue to be debated, and alternative actions can continue to be generated. Yet the practical field also changes while deliberation proceeds. Deadlines pass, institutions allocate resources, affected actors adapt, harms or opportunities accumulate, and the feasibility of later options changes. Closure becomes necessary because open deliberation itself occupies time and alters the situation.

The necessity of closure is therefore relational rather than merely administrative. A hospital, school, court, emergency organization, research institution, civic association, technical system, or public authority may need a stable commitment so that multiple actors can coordinate expectations and responsibilities. Suppliers need to know whether an implementation will proceed. Staff need role assignments. Affected subjects need to know which protections, obligations, or services apply. Monitoring systems need a defined object. Accountability needs an identifiable decision against which reasons and consequences can later be assessed. Without a bounded closure point, practical responsibility can diffuse into continuous discussion.

Closure also creates temporal legibility. A practical process becomes easier to re-construct when there is a distinguishable state at which one problem formulation, one authorized action, one implementation plan, or one temporary arrangement became operative. Such temporal markers support provenance and re-epistemization. Later actors can compare what was known before closure with what became visible

afterward. Where closure is informal or continuously shifting, the relation between evidence, authority, action, and consequence can become difficult to reconstruct.

The need for closure should remain object-specific. Different elements of praxis can close at different times. Problem recognition can close provisionally while causal reconstruction remains open. An operational plan can close for the next month while the longer institutional strategy remains under review. A temporary safety measure can become active before a final evaluation standard is agreed. This modularity avoids treating an entire practical process as either wholly open or wholly closed.

Definition 10.479 (Closure object). A *closure object* is the specific question, judgment, commitment, role allocation, implementation configuration, evaluation frame, or institutional arrangement whose present stabilization is required for a defined practical function.

Identifying the closure object limits overreach. A body authorized to close an operational question does not thereby close the underlying scientific controversy. A majority vote on a temporary programme does not settle every value dispute surrounding the programme. A completed evaluation does not eliminate the possibility of later evidence. Closure should therefore track the authority and function of the process that produced it.

The consequences of continued openness also belong to closure analysis. Deliberation can have epistemic and democratic value, but it can also produce opportunity loss, exhaustion, strategic delay, uncertainty for affected actors, and de facto continuation of an existing arrangement. In some situations, those who benefit from the status quo possess greater capacity to sustain extended process than those who bear ongoing burdens. The decision to continue deliberating can therefore distribute consequences unevenly.

At the same time, closure can be premature. A process can close before affected positions are recognized, before a decisive uncertainty is investigated, before alternatives are meaningfully considered, or before the responsible institution has implementation capacity. The necessity of closure consequently does not establish that immediate closure is warranted. It establishes that the practical process requires an explicit account of when continued openness ceases to be the more responsible orientation.

Proposition 10.480 (Bounded necessity of closure). *Where continued openness materially affects coordination, responsibility, consequence, or future option structure, application-dominant praxis requires an explicit closure decision concerning the relevant practical object even when the appropriate decision is to extend inquiry or deliberation for a further bounded interval.*

The proposition includes the possibility of intentionally continued openness. A decision to collect more evidence for three months, to conduct another participatory round, or to delay authorization until a safety threshold is met can itself constitute a form of bounded closure because the institution has stabilized what will happen during the interim and when reconsideration will occur. The key difference lies between governed openness and indefinite drift.

10.17.2 Decision before Complete Knowledge

Section 10.8 established that epistemic sufficiency for action differs from epistemic completeness. Practical closure extends that argument from the moment of decision to the wider configuration that makes commitment operational. The relevant problem is not whether every uncertainty has been resolved. It is whether the present evidential state, practical stakes, available alternatives, consequences of delay, reversibility, distribution of burden, and monitoring capacity support closing the current question for the intended horizon.

Decision before complete knowledge requires explicit discipline because closure can psychologically and institutionally transform provisional assumptions into apparent facts. Once resources are allocated and roles assigned, organizations often begin to speak as though the selected problem formulation and theory of change were established. Repetition in documents, dashboards, and routines can further stabilize the representation. A closure architecture should therefore preserve the difference between what was observed, what was inferred, what was assumed, and what was accepted pragmatically for purposes of action.

The closure threshold should also be sensitive to consequence. A small reversible experiment can close under a thinner evidential state than an intervention that creates long-term dependency, exposes people to severe harm, or forecloses future options. Conversely, severe harm from delay can justify closure under substantial uncertainty when waiting would itself produce unacceptable consequences. Epistemic demands and practical urgency interact; neither can be inferred from uncertainty alone.

Definition 10.481 (Closure sufficiency). *Closure sufficiency* is the condition in which the available evidence, practical judgment, authority, capability, uncertainty characterization, and consequence architecture are adequate for stabilizing a specified closure object for a stated horizon, given the expected consequences of both commitment and continued openness.

Closure sufficiency is purpose-relative. A configuration sufficient to authorize a pilot can remain insufficient for scale-up. A temporary restriction can be justified for immediate protection while evidence for permanent institutionalization remains incomplete. A preliminary evaluation can close a funding tranche while a long-horizon causal claim remains open. The closure record should therefore state the function for which sufficiency was judged.

The possibility of unknown unknowns remains. No closure process can document uncertainty that has not entered recognition. This limitation increases the importance of diversity in observation, anomaly reporting, protected dissent, reversibility, and monitoring of unexpected consequences. The response to unrecognized uncertainty is not exhaustive anticipation but greater capacity to detect and respond when the practical field departs from expectation.

Decision before complete knowledge also creates responsibility for epistemic compression. Practical institutions often need concise representations of complex evidence. Summaries, risk categories, traffic-light systems, model outputs, briefing notes, and decision dashboards can support action, but they can also hide uncertainty and disagreement. Closure should therefore preserve links to fuller provenance proportionate to consequence. The practical representation can be compressed while remaining traceable to the evidential architecture from which it was constructed.

In some cases the decision to close is itself a hypothesis about future manageability. An institution can proceed because it believes that monitoring will detect problems early, rollback remains feasible, implementation can adapt, or affected actors can contest harmful developments. These beliefs should be treated as closure assumptions, not background certainties. Their failure can become a later trigger for revision or reopening.

Proposition 10.482 (Action-relative closure sufficiency). *The epistemic and institutional requirements for practical closure should vary with the scale, consequence, reversibility, distribution, uncertainty, monitoring capacity, and temporal urgency of the commitment being stabilized rather than with an abstract requirement of complete knowledge.*

This proposition carries forward the decision architecture of Section 10.8. Practical closure does not lower the value of knowledge. It locates knowledge within a consequential judgment about when the present state of inquiry is sufficient for a defined practical task and how remaining uncertainty will be governed after commitment.

10.17.3 Provisional Practical Closure

Provisional practical closure is the principal form of closure developed in this chapter. Its provisionality concerns the status of the practical commitment, not the seriousness of action. A provisional closure can authorize major expenditure, institutional restructuring, emergency protection, long-term monitoring, or difficult trade-offs. The term indicates that the closure is bounded by its stated horizon, assumptions, responsibilities, and conditions for later change.

Definition 10.483 (Provisional practical closure). *Provisional practical closure is a practical closure in which the authorized commitment is treated as sufficiently warranted for a specified function and horizon while the conditions under which its interpretation, continuation, scope, implementation, or legitimacy should be reconsidered remain institutionally and epistemically available.*

A strong provisional closure should specify several elements. It should identify the closure object and the practical end being pursued. It should identify the authority under which closure occurs and the positions responsible for implementation, monitoring, review, and repair. It should state the relevant evidence and assumptions, the residual uncertainty, the materially relevant disagreement, the expected distribution of benefit and burden, and the anticipated effects on future action space. It should distinguish temporary from path-creating components. It should also record revision, reversal, exit, and reopening pathways where they are materially relevant.

These elements need not always appear in one formal document. In complex institutions they can be distributed across authorization records, implementation plans, risk registers, dissent records, monitoring protocols, contracts, appeals procedures, and archival systems. What matters is practical linkage. Later actors should be able to reconstruct how the parts relate to the closure state.

Definition 10.484 (Practical closure dossier). *A practical closure dossier is a proportionate and versioned collection of the problem formulation, evidential basis, practical judgment, authorized commitment, responsible positions, residual uncertainty, residual disagreement, expected consequences, monitoring architecture, revision conditions, reversibility information, exit provisions, and reopening pathways associated with a practical closure.*

The dossier supports continuity across time. Personnel change. Institutions reorganize. Political or organizational priorities shift. An action can outlast the people who originally justified it. Without preserved closure context, later actors can inherit the commitment while losing its assumptions and limits. The result can be institutionalization by forgetting: a provisional arrangement persists because its provisional status is no longer visible.

Provisionality should therefore have an operational form. Time-limited authorization, scheduled review, staged expansion, threshold-based continuation, sunset clauses, reversible modules, renewal requirements, and periodic reauthorization can all make provisionality practically effective. Each mechanism has limitations. Frequent review can create instability. Sunset clauses can produce artificial deadlines. Staged expansion can delay benefits. The relevant design depends on consequence, uncertainty, institutional capacity, and the cost of reopening.

The legitimacy of provisional closure also depends on the authority to close. Participation and contestability from Section 10.12, responsibility from Section 10.13, and justice from Section 10.14 remain active. A technically well-documented closure can still be practically weak if the body making the decision lacks legitimate standing, if affected positions were systematically excluded, or if burdens are transferred to actors with little voice and limited exit.

Proposition 10.485 (Proportionality of closure architecture). *The documentation, participation, monitoring, review, reversal, and reopening architecture associated with provisional practical closure should become more explicit as consequence, irreversibility, uncertainty, duration, distributional asymmetry, and dependence increase.*

The proposition avoids making every closure administratively heavy. Routine low-consequence decisions can rely on concise records and ordinary supervisory revision. High-consequence collective commitments warrant richer closure architecture because later correction is more difficult and the cost of losing provenance is higher.

10.17.4 Residual Uncertainty

Residual uncertainty persists after closure because closure stabilizes action rather than eliminating epistemic incompleteness. Section 10.8 introduced the residual uncertainty profile as a traceable account of uncertainties remaining at a decision point. Practical closure carries that profile forward into implementation, where uncertainty can change status as new manifestations emerge.

Some uncertainty becomes less important after closure. A parameter range can prove operationally insensitive. A feared implementation barrier can fail to materialize. Other uncertainty can become more important. A weakly understood feedback can begin to dominate system response. An affected group can become visible. A local adaptation can alter the mechanism through which the intervention operates. Closure should therefore permit the uncertainty profile to evolve rather than freezing the pre-decision representation.

Residual uncertainty also needs ownership. If every unresolved issue is merely recorded without a responsible monitoring position, the register can become archival rather than practical. The closure architecture should connect material uncertainties to detection pathways, review intervals, contingency plans, and responsible roles where feasible. The responsible position need not solve the uncertainty alone; its function can be to ensure that relevant signals enter the reopening pathway.

Definition 10.486 (Uncertainty carriage). *Uncertainty carriage* is the continued linkage after practical closure between materially relevant residual uncertainties and the monitoring, interpretation, contingency, responsibility, and reopening arrangements through which those uncertainties can later affect praxis.

Uncertainty carriage prevents a common closure failure in which uncertainty is acknowledged in the decision document but disappears from operational practice. Once implementation begins, teams can focus on delivery metrics that are easier to measure than the uncertain relations that most affect safety, justice, or long-term consequence. A credible closure architecture keeps significant uncertainty connected to practical attention.

The form of carriage should vary with the uncertainty. Parameter uncertainty can be linked to sensitivity thresholds. Mechanism uncertainty can motivate process tracing or comparative monitoring. Boundary uncertainty can require observation beyond the immediate implementation unit. Uncertainty concerning affected positions can require ongoing participation and complaint channels. Normative uncertainty can require deliberative review rather than additional quantitative measurement. Systemic uncertainty can justify redundancy, stress testing, or tighter constraints on scale.

Residual uncertainty can also be distributed asymmetrically. Institutions can experience confidence because they control the implementation process while affected actors remain uncertain about access, safety, future dependency, or remedy. Closure records should preserve these positional differences rather than averaging them into one confidence statement. The uncertainty of a position with limited exit or high exposure can carry greater practical significance even if that position represents a small population.

Unexpected events create another challenge. A closure architecture cannot pre-specify every signal that should matter. Monitoring therefore needs some capacity for anomaly recognition beyond the variables anticipated at closure. Open reporting, protected escalation, qualitative observation, external review, and preservation of unusual cases can help institutions notice events that do not fit the original model.

Proposition 10.487 (Residual uncertainty after closure). *Where materially relevant uncertainty remains after practical closure, the practical warrant for continued commitment is strengthened when the uncertainty remains connected to proportionate detection, interpretation, contingency, and revision capacity rather than being treated as resolved by the act of closure itself.*

The proposition turns uncertainty into an ongoing governance object. Closure can simplify coordination, but it should not erase epistemic remainder from the practical system that now acts under it.

10.17.5 Residual Disagreement

Practical closure can occur without consensus. Sections 10.5, 10.12, and 10.14 have already shown that judgment, participation, and justice can contain durable disagreement concerning evidence, values, interpretation, priority, burden, authority, or acceptable risk. Closure requires a way to coordinate action when some of those disagreements remain materially unresolved.

Residual disagreement should first be distinguished from mere procedural loss. A

minority can disagree because it was outvoted even though its reasons were heard and preserved. Another group can appear to agree because participation was inaccessible, dissent was unsafe, or the practical vocabulary excluded its concern. These situations differ substantially. The closure record should therefore preserve the provenance of agreement and disagreement rather than infer legitimacy from the final vote or signature alone.

Definition 10.488 (Residual practical disagreement). *Residual practical disagreement* is a materially relevant divergence in evidence judgment, interpretation, value, priority, authority, consequence assessment, or practical orientation that remains after proportionate inquiry and deliberation at the point of authorized closure.

Residual disagreement can have different practical statuses. Some disagreement does not affect the present action. Participants can endorse the same intervention for different reasons. Some disagreement supports conditions on implementation, such as stronger monitoring or narrower scope. Some concerns warrant a formal minority report or protected dissent channel. Other disagreements challenge the legitimacy of the decision itself and can justify appeal, external review, or non-participation.

The practical significance of disagreement depends partly on what later evidence could reveal. A dissenting position can identify a mechanism that the majority considers unlikely. If the mechanism later appears, the preserved dissent becomes diagnostically valuable. A minority can also identify justice concerns that become visible only after implementation. Treating dissent as part of institutional memory therefore supports learning as well as participation.

Definition 10.489 (Disagreement carriage). *Disagreement carriage* is the preservation after closure of materially relevant dissent, its grounds, standing, practical implications, and available review pathways so that later evidence or consequence can reconnect the unresolved disagreement to institutional judgment.

Disagreement carriage should not create permanent veto by default. Coordinated action can require that an authorized body assign provisional priority among incompatible positions. The relevant discipline is to avoid rewriting the resulting priority as prior unanimity. An institution can state that a decision was authorized despite unresolved disagreement and record why the chosen orientation was accepted for the present horizon.

Residual disagreement also has a temporal structure. Some conflicts diminish as consequences become observable. Others deepen because implementation changes who bears burden or who possesses power. New disagreement can emerge from actors who were not previously affected. Closure should therefore preserve routes for new standing to arise where the relational field materially changes.

A further issue concerns the burden of dissent. Repeatedly requiring marginalized or less powerful actors to restate the same objection can shift the maintenance cost of institutional memory onto those actors. Where a dissent has been formally recorded, later review should be able to recover it without requiring complete re-performance of the original participatory labor. This is one reason why traceability and representation records matter.

Proposition 10.490 (Closure with preserved disagreement). *Collective practical closure can remain provisionally legitimate under residual disagreement when materially relevant dissent has received appropriate standing, its grounds and implications remain traceable, the authority for provisional priority is explicit, and viable pathways exist for*

later review where consequences or evidence materially change the dispute.

The proposition links closure to pluralism without requiring unanimity. Practical coordination becomes possible while disagreement remains available as part of the institution's epistemic and normative memory.

10.17.6 Conditions for Revision

Revision changes an existing practical commitment while retaining enough continuity that the process remains recognizably the same practical trajectory. Section 10.8 defined decision revisability, decision revision triggers, and revision capacity. Practical closure extends those concepts to the broader closure state, including problem formulation, ends, implementation, monitoring, responsibility, and institutional arrangements.

Revision can vary in depth. Parameter revision adjusts scale, timing, thresholds, or implementation details. Design revision changes the means while retaining the broad end. Orientation revision changes priorities or the interpretation of the problem. Governance revision reallocates authority, participation, or responsibility. Deep revision can reopen assumptions that were previously stabilized as part of the closure itself. The closure architecture should therefore avoid treating all revision as minor adaptation.

Conditions for revision can be pre-specified where the relevant uncertainty is known. A threshold can trigger dose reduction, scale adjustment, additional review, or temporary suspension. A scheduled review can reconsider the commitment after new evidence accumulates. A contractual clause can require renegotiation after a defined external change. Pre-specification reduces the risk that actors reinterpret unfavorable evidence merely to preserve prior commitment.

Some revision conditions necessarily emerge later. A new affected population can appear. A previously unknown interaction can be discovered. An institutional capacity can fail. A legal or normative standard can change. A better alternative can become reachable. The revision architecture therefore needs both predefined triggers and a pathway for recognizing unanticipated developments as materially relevant.

Revision also requires authority. Monitoring can reveal a problem without anyone having power to alter the commitment. Front-line actors can observe harm while escalation channels remain weak. Evaluators can identify failure while funding or governance arrangements lock the intervention in place. Closure should therefore connect detection to effective revision rights and clarify which actor can initiate, authorize, implement, and review a revision.

Definition 10.491 (Closure revision condition). A *closure revision condition* is a pre-specified or subsequently recognized change in evidence, consequence, value, capacity, affected position, institutional arrangement, or practical possibility that materially alters the warrant for one or more elements of an existing practical closure while leaving continued participation in the broader practical trajectory feasible.

The final clause distinguishes revision from exit and some forms of reversal. Revision modifies the shared commitment. Exit changes an actor's relation to it. Reversal seeks to undo or repair implemented effects. These responses can occur together, but their practical objects differ.

Revision should also account for path dependence. A formally revisable closure

can become increasingly difficult to change as sunk costs, organizational identity, infrastructure, contractual commitments, expectations, or political reputation accumulate. The review interval should therefore be sensitive to the possibility that waiting for stronger evidence will also reduce the capacity to respond to that evidence.

At the same time, excessive revisability can undermine action. Constant reconsideration can destabilize cooperation, make long-term investment impossible, exhaust participants, and prevent a sufficiently stable intervention from generating interpretable evidence. Revision architecture should balance corrigibility with the continuity needed for responsible implementation and learning.

Proposition 10.492 (Revision under practical continuity). *Practical closure should support revision when the warrant for a materially relevant element has changed while preserving sufficient continuity of responsibility, records, and institutional function for the revised trajectory to remain intelligible and accountable.*

Revision therefore represents the ordinary adaptive pathway of provisional closure. Reversal becomes relevant when modification is insufficient because an implemented commitment itself should be rolled back, restored, repaired, or terminated.

10.17.7 Conditions for Reversal

Reversal concerns the relation between closure and implemented consequence. Section 10.10 distinguished reversibility, partial reversibility, reversibility asymmetry, rollback capacity, and irreversibility. Practical closure must translate those concepts into governance conditions under which rollback or restoration becomes appropriate.

Reversal is not simply revision in the opposite direction. A revised programme can continue on a modified path. Reversal seeks to terminate or undo a prior commitment, restore an earlier condition where possible, or reconstruct a materially acceptable state after the commitment has become unsuitable. Because full restoration is frequently impossible, practical reversal often includes repair, compensation, rehabilitation, transition, or redesign rather than literal return.

Conditions for reversal can arise from severe harm, failure of an essential assumption, loss of authorization, discovery of unacceptable risk, inability to meet a protected value threshold, emergence of a substantially safer alternative, implementation breakdown, or evidence that expected benefits cannot plausibly justify continuing burdens. The relevance of each condition depends on the closure object and consequence profile.

Definition 10.493 (Reversal condition). *A reversal condition is a material development indicating that continuation or ordinary revision of an implemented commitment is no longer sufficiently warranted and that rollback, restoration, repair, termination, or transition to a substantially different practical configuration requires active consideration.*

Active consideration matters because a reversal trigger need not automatically mandate reversal. Rollback can itself create harm. People can have adapted to the intervention. Dependencies can have formed. Benefits can be distributed unevenly. An institution can discover that ending a flawed programme abruptly would expose vulnerable actors more severely than staged transition. Reversal judgment should therefore include the consequences of reversal itself.

The reversibility profile should be updated over time. A closure that was highly reversible at implementation can become less reversible as infrastructure, routines, legal rights, expectations, or relationships accumulate. The practical system should monitor not only performance but also changes in the cost and distribution of reversal. A shrinking reversibility window can justify earlier review even before failure becomes decisive.

Definition 10.494 (Reversal pathway). *A reversal pathway is the specified sequence of authority, detection, decision, operational rollback, restoration, repair, compensation, transition, and post-reversal monitoring through which a practical commitment can be materially reduced, terminated, or reconstructed.*

The pathway should distinguish positions. An intervention can be reversible for the institution while irreversible for affected subjects. Ending the intervention may stop future exposure but cannot restore lost opportunity, damaged trust, disclosed information, ecological loss, or accumulated dependence. A reversal record should therefore preserve residual harm and identify which consequences remain after rollback.

Reversal also requires preservation of the capability to return or transition. Technical knowledge can be lost after adopting one system. Alternative suppliers can disappear. Staff can be retrained away from prior skills. Data can become incompatible. Rights can be reorganized around the new arrangement. Option-preservation analysis from Section 10.10 therefore becomes part of closure design when future reversal is expected to remain important.

Proposition 10.495 (Reversal-sensitive closure). *Where a practical commitment derives part of its warrant from the possibility of later rollback, the closure architecture should preserve a credible reversal pathway and monitor changes in recoverability, affected positions, and residual harm throughout implementation.*

The proposition prevents reversibility from functioning as a purely verbal assurance. A closure justified as experimental, temporary, or reversible becomes weaker if the practical conditions of reversal are allowed to disappear during implementation.

10.17.8 Conditions for Exit

Exit differs from revision and reversal because its principal object is the actor–arrangement relation. Section 10.9 defined practical exit as termination or substantial relocation of an actor’s membership, attachment, or exposure within a practical arrangement. Practical closure should specify when exit is available, what capacities make it effective, and what responsibilities persist after departure.

Exit can provide protection against unacceptable burden, coercion, persistent failure, or loss of trust. It can also preserve autonomy where continued participation depends on consent. Yet exit is unevenly distributed. Some actors possess mobility, alternative institutions, financial reserves, legal rights, technical portability, or social networks that make departure feasible. Others are bound by necessity, dependency, geography, status, caregiving obligations, sunk investment, or the absence of alternatives. Formal exit rights can therefore coexist with very unequal effective exit capacity.

Conditions for exit can be voluntary, contractual, institutional, ethical, or protective. A participant can choose to leave after a change in terms. A professional can

withdraw when an arrangement violates a protected standard. An institution can end a partnership after governance failure. An affected subject can require a protected opt-out where participation would otherwise impose disproportionate risk. Each case requires attention to the burdens transferred to those who remain.

Definition 10.496 (Closure exit condition). A *closure exit condition* is a specified or subsequently recognized circumstance under which an actor can justifiably terminate or materially relocate its participation, membership, exposure, or commitment within an arrangement governed by an existing practical closure.

Exit conditions should connect to exit capacity. A right to leave can be practically empty if data cannot be transferred, benefits are forfeited, essential services disappear, retaliation is likely, or switching costs are prohibitive. Where meaningful exit forms part of the legitimacy of closure, the institution should protect the practical conditions that make exit usable.

Exit also creates obligations of transition. A service provider leaving a region can need to preserve continuity for dependent users. A member withdrawing from a collective can possess information or responsibilities that require handoff. A funder ending support can create abrupt burden for organizations that built capacity around the commitment. Exit can therefore require notice, data transfer, transition support, compensation, preservation of records, or staged reduction depending on the relation.

The *exit remainder* developed in Section 10.9 remains central. Departure changes the field for those who stay. Resources, legitimacy, capability, coordination, and burden can all shift. An exit decision should therefore evaluate both the departing actor's claim and the consequences distributed across the remaining arrangement.

Closure architectures can also misuse exit. Institutions can treat the theoretical possibility of leaving as sufficient answer to concerns about domination or burden even where practical exit is highly unequal. Conversely, powerful actors can use credible exit to extract favorable terms while less mobile actors absorb the resulting costs. Exit should therefore complement, rather than replace, voice, contestability, accountability, and repair.

Proposition 10.497 (Exit-sensitive practical closure). *Where continued participation materially depends on the availability of exit, practical closure should preserve effective exit capacity proportionate to the dependence involved and should account for transition obligations and the burden transferred to positions that remain.*

Exit can sometimes resolve a local conflict without reopening the shared arrangement. In other cases, repeated exit, asymmetric exit, or the departure of critical actors can signal that the closure itself requires reconsideration. This possibility leads to reopening deliberation.

10.17.9 Reopening Deliberation

Reopening deliberation restores one or more previously stabilized questions to active practical judgment. It is broader than ordinary revision because the institution reopens the grounds of closure rather than merely modifying implementation. The reopened object can include the problem formulation, evidential basis, ends, authority, justice profile, action space, institutional arrangement, or the legitimacy of continued commitment itself.

Reopening can be triggered by evidence, consequence, dissent, institutional change, value change, legal development, failure of an essential assumption, emergence of a new affected position, deterioration of trust, loss of capacity, or transformation of the wider practical situation. A scheduled review can also reopen deliberation without a crisis. Periodic reopening can be valuable where long-horizon consequences are difficult to observe during the original decision period.

Definition 10.498 (Reopening condition). A *reopening condition* is a material development, scheduled review point, or valid contestation event that requires one or more previously stabilized elements of practical closure to return to active inquiry, deliberation, judgment, or authorization.

Reopening requires standing. An affected actor can observe a problem while lacking access to the institution capable of reconsidering the decision. Employees can fear retaliation. External researchers can identify evidence but lack an authorized channel. Future consequences can be borne by populations not represented in the original process. The closure architecture should therefore specify who can initiate reopening, how evidence enters the process, which body has authority to respond, and what protections apply to dissent and escalation.

Reopening also requires memory. The practical closure dossier from Definition 10.484 enables later actors to reconstruct the earlier state rather than deliberating from a decontextualized present. The earlier reasons, assumptions, uncertainty, disagreement, and authority should remain distinguishable from later knowledge. This continuity supports the post-action re-epistemization developed in Section 10.16.

A reopened process should identify its scope. New evidence about one implementation mechanism does not necessarily reopen every normative premise. A legitimacy challenge can require broader reconsideration than a parameter update. Scope discipline protects both stability and responsiveness. It prevents small anomalies from destabilizing an entire institution while also preventing institutions from classifying deep problems as minor operational issues merely to avoid review.

Definition 10.499 (Reopening pathway). A *reopening pathway* is the institutional and procedural sequence through which a reopening condition can be recognized, submitted, assessed, authorized for renewed deliberation, connected to preserved closure provenance, and translated into a revised, reversed, exited, continued, or newly closed practical configuration.

The result of reopening need not be change. Deliberation can conclude that the existing commitment remains sufficiently warranted. Such reaffirmation should still update the closure record because the evidential and practical field has changed. Reopening can therefore produce continuation with stronger justification, narrower scope, new safeguards, revision, reversal, exit arrangements, or a new practical orientation.

Reopening also has costs. Frequent reopening can generate instability, strategic obstruction, process fatigue, and uncertainty for actors who depend on durable rules. Powerful actors can weaponize review procedures to delay protections or exhaust less-resourced participants. The threshold for reopening should therefore be proportionate to consequence and should distinguish materially relevant contestation from repetitive procedural disruption. Protected routes for urgent escalation can coexist with ordinary review intervals.

Proposition 10.500 (Reopenable practical closure). A *practical closure is more ro-*

bustly provisional when materially relevant changes in evidence, consequence, value, affected position, authority, capability, or institutional condition can reach a legitimate reopening pathway without requiring the practical system to lose all continuity each time reconsideration occurs.

The proposition completes the section's architecture. Practical closure is neither indefinite openness nor terminal finality. It is a governed stabilization in which commitment, responsibility, and coordination become possible while uncertainty, disagreement, revision, reversal, exit, and later deliberation remain structurally connected to the practical history that produced the closure.

This account also completes the philosophical architecture required before the book turns from application-dominant praxis to application methodology. Chapter 10 has developed the practical situation, problem formation, judgment, ends, action spaces, decision under incomplete knowledge, action and non-action, risk, power, participation, responsibility, justice, institutional praxis, research–application coupling, and practical closure. Section 10.18 now states the praxis-derived requirements that later decision, intervention, evaluation, and adaptive methodologies must preserve, while leaving their concrete architecture to Chapter 11.

10.18 Methodological Requirements of Application-Dominant Praxis

Sections 10.1–10.17 have developed application-dominant praxis as a domain-general architecture for consequential action under incomplete knowledge, plural values, unequal power, distributed agency, institutional dependence, and revisable closure. The role of the present section is narrower than the construction of an applied methodology. It identifies the requirements that any later methodological specification should preserve if it is to remain answerable to the praxis architecture developed in Chapter 10. Its objective is therefore to establish a disciplined handoff to Chapter 11 without pre-selecting decision procedures, modelling strategies, participatory arrangements, intervention designs, monitoring systems, or evaluative techniques. The discussion is organized around practical provenance and five requirement clusters concerning decision, intervention, evaluation, adaptation, and the scope of the handoff. The mode of argument is architectural and derivative: each requirement is traced to a practical condition already established in this chapter.

The boundary matters because operationalization can change the practical object. A decision rule can compress plural values into one criterion; a model can make some relations more legible than others; an intervention protocol can privilege one mechanism or scale; and an evaluation frame can determine which effects become durable in institutional memory. Chapter 10 therefore cannot treat method as neutral implementation. At the same time, specifying the concrete architecture through which methods are selected, combined, sequenced, monitored, and revised belongs to Chapter 11. The present section states what that architecture must remain accountable to.

Definition 10.501 (Practical methodological requirement). *A practical methodological requirement* is a condition that an applied method or methodological arrangement should satisfy because a materially relevant feature of the practical situation, responsibility structure, uncertainty, value configuration, power relation, or closure archi-

Table 10.18: Praxis-derived requirements for applied methodology

Requirement cluster	Inherited practical condition	Requirement on later methodology	Information that should remain recoverable
Practical provenance	Situated judgment, authority, plural values, uncertainty, and responsibility	Preserve why a method is being used and which practical condition gives it relevance	Practical object, assumptions, authority, scope, uncertainty, affected positions, and revision conditions
Decision	Evolving action spaces, urgency, risk, disagreement, and provisional closure	Make commitment structure inspectable without presenting residual uncertainty or value conflict as already resolved	Alternatives, reachability, consequence structure, evidential burden, authorization, reversibility, and residual disagreement
Intervention	Relational transformation, unequal power, timing, scale, depth, and institutional dependence	Preserve the relation among target, proposed mechanism, implementation conditions, safeguards, and responsibility	Target, mechanism hypothesis, affected positions, implementation authority, timing, scale, monitoring needs, repair, and exit conditions
Evaluation	Heterogeneous ends, distributed consequences, delayed effects, and action-generated evidence	Preserve evaluative plurality and the distinction between observed change, attribution, and practical significance	Evaluative standpoint, baseline or comparator, temporal horizon, affected positions, attribution uncertainty, and residual effects
Adaptation	Changing evidence, evolving situations, feedback, practical failure, and revisable closure	Connect materially relevant change to governed reassessment without allowing unrecorded methodological drift	Revision trigger, version history, protected commitments, responsible authority, rollback or exit conditions, and research-return conditions
Methodological handoff	Coupled decision, intervention, evaluation, learning, and closure	Carry the preceding requirements into methodological specification while leaving concrete method architecture open	Requirements record, unresolved tensions, boundary conditions, and questions requiring methodological construction in Chapter 11

ture would otherwise be lost, distorted, or rendered difficult to govern.

Table 10.18 summarizes the handoff. The table states requirements and does not prescribe the methods through which they should be satisfied.

10.18.1 Practical Provenance of Method

Application-dominant praxis gives methods practical force through their relation to a situated problem. A technically coherent procedure can remain practically inappropriate if its object, assumptions, authority, burden, or consequences do not fit the field in which it is used. The first requirement is therefore provenance: later methodological choices should remain reconstructable as responses to a specified practical situation rather than appearing as self-justifying technical selections.

Practical provenance includes at least the problem formulation being acted upon, the relevant ends and value conflicts, the positions materially affected, the scope and temporal horizon of the decision, the authority under which action proceeds, the uncertainties that matter to the commitment, and the conditions under which the methodological arrangement should be reconsidered. These elements need not be represented in one standardized format. Their function is to keep the relation between praxis and technique visible.

This requirement also limits methodological substitution. A method can supply information, organize comparison, structure participation, or support intervention without inheriting authority to settle a normative or institutional question that lies

outside its function. Practical provenance therefore records both what a method is expected to contribute and what remains to be judged elsewhere in the practical architecture.

Proposition 10.502 (Praxis accountability of applied method). *An applied methodological arrangement remains answerable to application-dominant praxis when its practical object, authority, assumptions, relevant uncertainties, affected positions, and revision conditions remain sufficiently explicit to reconstruct why the arrangement was appropriate to the commitment for which it was used.*

10.18.2 Requirements on Decision Methodology

Chapter 10 has treated decision as commitment under incomplete knowledge within an evolving action space. A later decision methodology should therefore preserve more than an ordering of alternatives. It should make clear what is being decided, which alternatives are practically reachable, what consequences are material, which uncertainties remain, how urgency and delay matter, who has authority to commit, and which forms of disagreement survive the decision.

The requirement is proportional to commitment depth. A reversible pilot can support a different evidential burden from a large irreversible institutional commitment. Decisions with asymmetric consequences should preserve information about who bears risk and who retains the capacity to recover or exit. Decisions that foreclose future options should make that loss visible rather than treating it as a secondary implementation detail.

Decision methodology should also preserve the distinction between evidential support and practical authorization. Evidence can alter the warrant for a commitment without itself determining the relevant value weights, institutional authority, or acceptable distribution of risk. Chapter 11 may operationalize these distinctions through different decision methods, but the distinctions themselves are inherited constraints on those methods.

10.18.3 Requirements on Intervention Methodology

Intervention in application-dominant praxis is a purposive attempt to alter a relational field. A later intervention methodology should therefore keep the proposed object of change distinct from the mechanism through which change is expected to occur. It should also preserve the conditions under which the mechanism is expected to operate, the scale and timing at which action is authorized, the positions that may be differently affected, and the institutional capacities required for implementation.

Power and responsibility enter the requirement directly. The ability to intervene does not by itself establish the legitimacy of the intervention object, the acceptable depth of transformation, or the distribution of burdens. Methodological specification should therefore retain who defines the target, who authorizes action, who implements it, who can contest it, and who remains responsible for monitoring, repair, compensation, or exit.

Intervention methodology should further preserve uncertainty about mechanism and downstream consequence. An intervention can generate evidence while also changing the field in ways that complicate later inference. Monitoring and evaluation requirements should therefore be anticipated at the point of intervention design

without being fully specified in Chapter 10.

10.18.4 Requirements on Evaluation Methodology

Evaluation inherits the plural ends and distributed consequences of practical action. A later evaluation methodology should distinguish observed change from causal or generative attribution, and attribution from practical or normative assessment. The same observed outcome can carry different significance across positions, temporal horizons, or evaluative standpoints. Evaluation should therefore preserve enough provenance to show whose effects are being assessed, over what interval, against which comparator, and under which criteria.

Evaluation also requires historical discipline. Action can produce immediate effects, delayed consequences, altered relations, changed capacities, foreclosed options, institutional learning, or residual obligations. A short-horizon indicator can be useful without exhausting practical consequence. Where the intervention itself changes categories, observation regimes, or participation, evaluation should record those changes because the evidential basis can become endogenous to the practical process.

The requirement is therefore evaluative transparency rather than one preferred metric. Chapter 11 develops concrete evaluative architectures. Chapter 10 requires only that later evaluation remain traceable to the ends, affected positions, uncertainty, responsibility, and closure conditions that made evaluation practically consequential.

10.18.5 Requirements on Adaptive Methodology

Application-dominant praxis unfolds in changing fields. Evidence can accumulate, mechanisms can fail, institutions can change, affected positions can become newly visible, and earlier decisions can alter the action space itself. A later adaptive methodology should therefore connect materially relevant change to governed reassessment rather than allowing adjustment to occur through unrecorded drift.

The principal requirement is a revisable but accountable relation among observation, interpretation, authorization, and change. Some revision triggers can be anticipated through thresholds or review dates. Others arise through failure, contestation, new evidence, model breakdown, unintended consequence, or altered institutional conditions. The methodological architecture should preserve which trigger occurred, what component is being reconsidered, who can authorize the change, what commitments remain protected, and whether revision, reversal, exit, or renewed research is the appropriate response.

Adaptation should also preserve methodological memory. Replacing a model, criterion, intervention sequence, or monitoring regime can improve practical fit while weakening comparability with earlier stages. Version history and reasons for change therefore matter for responsibility and learning. Research-return triggers developed in Section 10.16 should remain available when local adjustment no longer provides an adequate response to the epistemic problem.

10.18.6 Scope of Praxis-Derived Methodological Requirements

The requirement clusters developed in this section close Chapter 10 at the level appropriate to practical philosophy. They constrain methodological specification without determining its concrete architecture. In particular, Chapter 10 does not decide which diagnostic, formal, historical, interpretive, participatory, decision, intervention, monitoring, or evaluative methods should be selected; how several methods should be combined or sequenced; how outputs should be translated across method interfaces; or how a complete intervention lifecycle should be organized. Those questions belong to Chapter 11.

A compact handoff can therefore be represented as a requirements record rather than as a preconstructed methodology.

Definition 10.503 (Applied-method requirements record). An *applied-method requirements record* is a versioned account of the practical conditions that materially constrain later methodological specification, including the practical object, relevant ends and value conflicts, affected positions, authority, uncertainty, risk and reversibility, responsibility, closure and reopening conditions, and any unresolved tensions that concrete methods must preserve or address.

The record is intentionally incomplete as a method design. It tells Chapter 11 what should remain visible when techniques are operationalized, while leaving method selection and composition open to the practical object and available evidence. It also supports recoupling with research because unresolved epistemic questions can remain marked rather than being silently converted into technical assumptions.

Proposition 10.504 (Boundary between praxis requirements and methodological specification). *The Chapter 10–Chapter 11 boundary is preserved when application-dominant praxis supplies requirements on methodological adequacy and Chapter 11 alone specifies the organized methods, combinations, interfaces, sequences, monitoring arrangements, and revision procedures through which those requirements are operationalized.*

Proposition 10.504 closes the numbered argument of Chapter 10. Application-dominant praxis has been developed through practical contradiction, situation, problem formation, judgment, ends, action spaces, decision under incomplete knowledge, action and non-action, risk, power, participation, responsibility, justice, institutional praxis, research–application coupling, and practical closure. Section 10.18 adds the final constraint: when this architecture becomes methodological, its practical provenance, uncertainty, responsibility, and revisability should remain recoverable.

Chapter 11 takes the applied-method requirements record as an input and develops the methodological architecture itself. It specifies practical diagnosis, operational objects, method selection and combination, evidential conditions of commitment, decision analysis, scenario construction, robust and adaptive decision-making, formal and interpretive models, participatory methods, intervention target and design choices, monitoring, feedback, evaluation, failure repair, exit, and integrated intervention design. Substantive economic specialization remains deferred until the domain-general architecture has been completed at the end of Part IV.

Chapter 11

Decision and Intervention Methodologies

Chapter 11 develops the meta-methodological architecture of decision and intervention within application-dominant Generative Relational praxis. Its role in Part IV is to receive the praxis-derived methodological requirements established in Chapter 10, Section 10.18, and construct the organized methods through which diagnosis, practical-orientation specification, evidence-to-commitment translation, decision, intervention, monitoring, evaluation, revision, and exit can be conducted. The chapter therefore owns method selection, method combination, interface transformation, sequencing, monitoring architecture, and intervention-lifecycle design. Its objective is methodological coordination under conditions in which knowledge, values, institutional capacities, action spaces, relations, and future consequences can remain incomplete or change during the practical process. The discussion combines conceptual reconstruction, methodological comparison, locally justified formalization, historical interpretation, participatory method, and intervention design. Domain-general scope is preserved until the final section, where the architecture is specified minimally for economic praxis and handed to Part V.

Chapter 10's substantive account of ends, practical judgment, power, participation, responsibility, justice, risk, closure, and research-application recoupling is treated here as inherited practical structure rather than re-taught as methodological content. Those elements enter Chapter 11 through requirements, records, constraints, authority relations, and revision conditions that concrete methods must operationalize. This distinction permits Chapter 11 to develop technique without granting technique authority over the practical commitments from which its relevance is derived.

The chapter does not propose a universal decision procedure or a completed catalogue of GR methods. Different histories and relational fields can generate different practical orientations, criteria, evidence requirements, action spaces, institutional responsibilities, forms of intervention, and methodological combinations. A small reversible action can require a compact design, while a long-duration institutional transformation can require historical reconstruction, participatory governance, multiple models, staged authorization, independent monitoring, repair capacity, and residual obligations. The chapter therefore provides distinctions, interfaces, situation maps, candidate orientations, design dimensions, boundary conditions, and reopening rules

through which locally appropriate methods can be composed. These resources remain provisional: later inquiry and practice may disclose additional situation dimensions, methods, or practical orientations that are more adequate to particular fields.

Several familiar practical objects accordingly change status at the Chapter 11 boundary. Goals and criteria are received as historically situated and relationally conditioned practical objects and are methodologically specified only to the degree required for decision or intervention. Evidence epistemology and evidence-generation methods remain primarily in Chapter 5 and Part III; Chapter 11 addresses the narrower problem of how an inherited epistemic state can warrant practical commitment at a particular depth of action. Formal models and optimization remain powerful local methods while their authority depends on the practical representation, normative inputs, historical transport, regime stability, and institutional use through which their outputs acquire consequence.

Sections 11.5 and 11.6 add two explicitly open meta-methodological resources. The first maps practical and epistemic situations along overlapping dimensions such as observability, probabilistic characterizability, model agreement, historical transport, dynamical condition, turbulence, possible critical transition, stakes, reversibility, time pressure, performativity, relational heterogeneity, power, and responsibility. The second identifies considerations and candidate practical orientations that can become salient under some configurations, including value co-articulation, relational viability and transformation, reversibility, option preservation, responsibility retention, review of self-reinforcing power, epistemic plurality, and proportionate commitment. Neither list is presented as exhaustive, and none of the candidate orientations is treated as an invariant GR good. Their relevance remains situated, contestable, and revisable.

A central methodological distinction concerns epistemic content and practical uptake. Observation, classification, interpretation, communication, recommendation, and institutional recognition can generate knowledge about a field. Their uptake can also change the field by altering standing, expectations, eligibility, access, coordination, allocation, or institutional response. Chapter 11 therefore treats epistemic events as possible participants in practical history. Monitoring, forecasts, administrative classifications, formal recommendations, and machine-mediated outputs can remain informational or become performative according to how they enter action.

Historical ordering provides another organizing principle. Practical time can be represented through partial-order relations among events when sequence and dependence are analytically important, while scalar time remains useful for duration, deadlines, rates, delays, and synchronization. Subjects can likewise be represented historically through relations, classifications, commitments, capacities, institutional positions, and transformations whose order contributes to present practical possibility. Partially ordered histories and related computational structures remain optional model forms under the book's ontological-suspension commitment.

The chapter maintains methodological pluralism throughout. Statistical forecasting, causal inference, dynamical systems, stochastic models, networks, higher-order relations, field models, operator representations, partial-order history models, agent-based simulation, optimization, and sensitivity analysis can each support particular practical questions. Historical reconstruction, legal and institutional interpretation, local knowledge, naturalistic expertise, narrative understanding, deliberation, participatory mapping, co-design, and contestability provide partially irreducible forms

of access. Formal and natural-scientific methods can provide consistency, explicit assumptions, operationalization, computational comparison, and empirical testing where the field permits them; historical, interpretive, naturalistic, and participatory approaches can preserve forms of context, meaning, tacit recognition, and situated knowledge that are difficult to reduce to the same formal language. Each family also has limitations. Methodological composition therefore follows the practical object, available evidence, inferential task, consequences of error, responsibility structure, and required form of accountability rather than a fixed hierarchy of methods.

Decision analysis begins with evolving action spaces. Available actions can depend on resources, authority, legal conditions, institutional readiness, knowledge, coordination, prior commitments, and generated capacities. Scenario construction extends decision analysis into alternative histories, including counterfactual, adverse, transformative, branching, and long-horizon pathways. Robust and adaptive methods compare commitments across these histories while preserving uncertainty and the possibility that the action space itself changes.

One section is reserved for decision-making under critical-transition uncertainty. The chapter treats criticality as a model-relative and revisable practical hypothesis rather than a universal diagnosis. When defensible models admit possible qualitative transition, ordinary local inference can require qualification through regime-sensitive evidence, multiscale monitoring, model plurality, staged commitment, option preservation, and attention to intervention-induced transitions and incomplete reversibility.

Formal and quantitative models are then treated as a family of representations rather than a hierarchy of authority. Forecasting, causal modeling, dynamical and stochastic systems, network and higher-order models, field and operator representations, partial-order histories, history weights, agent-based models, simulation, optimization, sensitivity analysis, and model-risk analysis each answer different questions. Their practical force depends on assumptions, semantics, validation, and the relation between the model's validity domain and the commitment for which it is used.

Intervention methodology develops target, timing, scale, depth, and design while preserving their meta-level status. Intervention design is a situated composition drawn from a context-sensitive repertoire. Practical orientation, intervention object, mechanism, enabling conditions, history-space effects, observation, responsibility, revision, and exit can each become important, but their relevance and required resolution differ across interventions. Experimental and pilot intervention then provide one possible mode of practical learning within this broader architecture.

Monitoring, feedback, evaluation, repair, exit, and rollback make the architecture recursive. Observation can generate evidence and change behavior. Feedback can revise models, criteria, action spaces, or intervention sequence. Evaluation can concern immediate outcomes, relations, capacities, structures, distributions, option spaces, or historical consequences. Repair and compensation preserve responsibility after failure, while exit and rollback distinguish termination from historical restoration and keep residual obligations visible.

Before the chapter integrates these methods, Section 11.26 develops six illustrative boundary conditions of formal evidence-to-decision systems: evidential-normative underdetermination, responsibility retention, human-relational distance, temporal and historical transport, regime-sensitive reliability near critical transitions, and re-

flexive or performative feedback. The six conditions are examples rather than a completed list; other fields can disclose additional boundaries to formal closure. They show why even technically coherent decision systems can require institutional judgment and recursive revision. AI-assisted systems appear as one important contemporary instance, while their substantive economic and political-economic consequences remain the work of Chapter 18.

The chapter culminates in integrated intervention design. Integration is treated as a configurable and versioned coordination architecture rather than a mandatory pipeline. Diagnosis, historical-relational subject reconstruction, situation mapping, situated practical orientation, epistemic conditions, scenario construction, decision, intervention, monitoring, evaluation, model revision, action-space revision, and exit can be connected through explicit provenance, responsibility, and reopening relations. Different projects can omit, combine, reorder, deepen, or replace components according to their field and commitment profile. The method itself can become an object of revision when practice reveals that the inherited methodological repertoire is inadequate.

The final section prepares the transition to substantive Generative Relational Economics. It provides only the minimal domain-specification interface required to interpret general subjects, relations, resources, institutions, values, representations, histories, and interventions economically. Detailed economic architecture, allocation, generative value, and generative spacetime remain the work of Part V.

The chapter is organized into six analytical blocks. Sections 11.1–11.4 establish the meta-methodological orientation through application-dominant method, diagnosis, situated evaluative formation, and epistemic conditions of practical commitment. Sections 11.5–11.6 map practical–epistemic situations and develop an open repertoire of situated considerations and candidate orientations. Sections 11.7–11.14 develop decision methods through evolving action spaces, alternative histories, robustness, adaptation, critical-transition uncertainty, formal and quantitative models, historical and interpretive analysis, and participatory methods. Sections 11.15–11.20 develop intervention construction through target, timing, scale, depth, situated design, and experimental or pilot intervention. Sections 11.21–11.26 develop the recursive lifecycle and identify illustrative boundary conditions of formal evidence-to-decision systems. Sections 11.27–11.28 integrate the architecture and specify its economic interface.

The objective of Chapter 11 is therefore to make application-dominant praxis methodologically articulable while preserving the epistemic, historical, relational, institutional, and normative openness established earlier in the book. The chapter supplies a meta-framework through which different methods can be selected, combined, revised, contested, and documented in relation to the practical field they address. Part V begins from this methodological inheritance and develops the substantive relational architecture of economic systems.

11.1 Methodological Architecture of Applied Praxis

Chapter 10 established application-dominant praxis as a domain-general architecture for consequential action and closed by stating the praxis-derived requirements that later methodology should preserve. The role of the present section is to begin methodological construction at the point where Chapter 10 deliberately stopped. Its objective

is to specify the components through which inherited practical requirements become an organized methodological task: methodological specification of practical orientation, decision objects, intervention objects, method selection, method combination, and method revisability. The mode of argument is architectural and translational. Praxis-level commitments are treated as inputs and constraints; the present chapter owns the procedures, representations, interfaces, and combinations through which they acquire operational form.

Methodological construction is consequential because a method does more than organize information. It specifies what will be observed, which distinctions will be stabilized, what counts as an alternative, how consequences will be represented, which uncertainties remain visible, whose knowledge can enter the analysis, and which forms of revision remain available. The task is therefore to operationalize without silently replacing the practical object. A broad commitment to reduce vulnerability can become a comparison among institutional designs, a sequence of local interventions, a threshold rule, a participatory process, or a portfolio of reversible experiments. Each specification makes some features more legible while creating representation and interface losses that should remain reconstructable.

The same discipline applies to epistemic and historical objects inherited from earlier chapters. Epistemic events, practical subjects, action spaces, power relations, and responsibility structures are not redefined here. They become methodological inputs whose representation must be chosen for the practical function at hand. A partially ordered history, a labeled 2-complex, a statistical model, an interpretive reconstruction, or a participatory map can therefore be selected when it provides relevant access, while remaining an optional representation under the book's ontological-suspension commitment.

This chapter consequently treats method as a family of organized procedures rather than as a synonym for formal modelling. Historical reconstruction, interpretive analysis, participatory mapping, statistical estimation, causal analysis, simulation, scenario construction, optimization, deliberation, monitoring, pilot intervention, evaluation, and adaptive revision can perform differentiated methodological functions within application-dominant praxis. Their relevance depends on the inherited practical object, the epistemic task, temporal horizon, distribution of consequence, and institutional capacity. Methodological architecture concerns fit, combination, interface governance, and revision across a practical lifecycle.

Definition 11.1 (Applied method). An *applied method* is a specified and revisable procedure, representational practice, analytical technique, participatory arrangement, or intervention protocol used to perform a practical methodological function within a consequential relational field.

Definition 11.1 is intentionally broad. A method can construct evidence, compare alternatives, disclose relations, organize participation, estimate consequences, stage an intervention, monitor change, or support revision. The same method can perform different functions in different practical architectures. A simulation used to explore possible trajectories performs a different role from the same simulation used to justify a threshold decision. A participatory process used to identify affected relations performs a different role from one used to authorize a collective commitment. Methodological description should therefore record function as well as technique.

Table 11.1 summarizes the six methodological components developed in this section. The table serves as an orientation map for the remainder of Chapter 11 rather

Table 11.1: Core components of applied methodological architecture

Methodological component	Practical object	Primary function	Characteristic discipline
Practical orientation	Ends, values, affected positions, constraints, uncertainty, and temporal horizon	Preserve the direction and conditions of consequential praxis during operationalization	Orientation provenance, scope, plural values, and revision conditions
Decision object	A bounded commitment among practically reachable alternatives	Organize comparison, thresholding, authorization, and provisional closure	Alternative clarity, consequence structure, uncertainty, authority, and residual disagreement
Intervention object	A targetable relation, condition, capacity, institution, rule, or generative configuration	Organize purposive transformation through mechanisms and implementation pathways	Target–mechanism fit, scale, timing, safeguards, monitoring, and repair
Method selection	A methodological requirement generated by the practical situation	Choose procedures capable of performing the required epistemic or practical function	Fitness for purpose, feasibility, burden, uncertainty, contestability, and provenance
Method combination	A practical task requiring several partially irreducible forms of access or action	Coordinate differentiated methods across diagnosis, decision, intervention, and evaluation	Interface clarity, translation discipline, sequencing, triangulation, and preserved disagreement
Method revisability	A changing situation, evidence state, value configuration, or implementation trajectory	Govern alteration, replacement, retirement, or recoupling of methods over time	Versioning, revision triggers, continuity, comparability, and methodological memory

than as a complete taxonomy of applied methods.

The architecture in Table 11.1 provides the chapter’s starting discipline. Applied methods are selected for practical functions that arise from a situated orientation. Decision objects and intervention objects specify different kinds of practical work. Method combinations preserve differentiated forms of access while coordinating them. Revisability keeps the methodological architecture responsive to evidence and consequence. The remainder of the chapter develops these functions in increasingly concrete form, beginning with practical diagnosis in Section 284.

11.1.1 Methodological Specification of Practical Orientation

A practical methodology receives an inherited orientation whose structure must be specified sufficiently to guide method choice without reopening the substantive theory of ends developed in Chapter 10. Practical orientation includes the valued direction of action together with the problem formulation, affected positions, temporal horizon, constraints, capacities, uncertainty, authority, and revision conditions that make the direction practically meaningful. It therefore carries more information than a goal statement. Two projects can share the same nominal goal while requiring different methods because their histories, relations, institutional capacities, risks, or reversibility differ substantially.

Methodological work should preserve this orientation as a living object rather than translating it immediately into one indicator or objective function. Premature compression can create a false appearance of precision. A plural practical orientation may contain a protected threshold, several compatible ends, unresolved value conflict, a requirement for participation, a preference for reversible commitments, and a long-horizon concern for future agency. A method that captures only the easiest measurable component can shift the practical orientation while leaving the shift unacknowledged.

Definition 11.2 (Practical orientation profile). A *practical orientation profile* is a structured record of the problem formulation, ends, relevant values, affected positions, practical horizon, constraints, capacities, uncertainties, authority relations, acceptable forms of commitment, and revision conditions that jointly orient an applied methodological process.

The practical orientation profile performs several functions. It provides a reference against which later methodological drift can be detected. It distinguishes changes in method from changes in practical purpose. It gives participants a common object for contestation when they disagree about ends, criteria, or scope. It also prevents later stages from treating a temporary operational proxy as though it were the original practical object.

Practical orientation has a temporal structure. Some ends concern immediate protection, others medium-term stabilization, institutional transformation, capability formation, or preservation of future options. The same intervention can support one horizon while weakening another. Methodological design should therefore identify which horizons are relevant and how they interact. A rapid decision method may be appropriate for immediate stabilization while a slower participatory and historical process develops the basis for longer-horizon institutional change. The methods can coexist when their functions and authority are differentiated.

Orientation also has a positional structure. A practical condition can appear differently from the standpoint of decision-makers, implementers, affected subjects, future maintainers, or actors who bear residual risk. Applied methodology should record these positional differences where they are materially relevant. This does not require that every practical judgment be reduced to a collection of viewpoints. It requires sufficient representation of the relations through which different positions encounter consequences, possess knowledge, and exercise agency.

A practical orientation can contain protected commitments. These may include rights, safety constraints, ecological limits, institutional duties, or participation requirements that should remain visible when methods compare alternatives. Treating every commitment as a tradable criterion can alter the normative architecture of the practical problem. Method selection should therefore distinguish between values that enter comparative evaluation and constraints that define the admissible region of action.

Definition 11.3 (Orientation constraint). An *orientation constraint* is a practical condition that limits the admissible use of methods, alternatives, or interventions because violating it would materially conflict with a protected value, responsibility, right, safety requirement, institutional duty, or closure condition within the practical orientation.

Orientation constraints can themselves be revisable when their basis changes, but revision should be explicit. A methodological workflow becomes difficult to govern when a constraint is relaxed informally during implementation because it obstructs a preferred alternative. The profile should therefore identify who can authorize changes, what evidence is relevant, which affected positions should participate, and whether the change reopens the practical judgment more broadly.

The practical orientation profile is also the starting point for methodological pluralism. Different parts of the orientation can require different forms of access. Historical reconstruction may be required to understand how current constraints formed. Quantitative analysis may estimate the distribution of consequences. Interpretive

work may clarify the meaning of an institutional category. Participation may reveal burdens or capacities weakly represented in administrative data. Simulation may explore future trajectories. A practical orientation therefore creates a set of methodological requirements rather than a single preferred method.

Proposition 11.4 (Orientation precedes methodological compression). *When a practical orientation contains materially relevant plural values, positional differences, uncertainty, or protected constraints, methodological compression into a single criterion or representation should follow explicit specification of those elements and preserve a record of what is retained, transformed, and omitted.*

Proposition 11.4 does not prohibit simplification. Practical action often requires bounded representations. The proposition establishes a provenance discipline: simplification should remain connected to the richer practical orientation from which it was derived. This becomes especially important when the simplified representation later acquires institutional authority.

The practical orientation profile therefore performs the first methodological specification of the requirements inherited from Chapter 10. It makes the inherited orientation operational enough to guide method choice while preserving plurality, history, position, and revisability. The next task is to identify the object of decision within that orientation.

11.1.2 Decision Objects

Decision methodology requires a bounded object of commitment. A practical situation can contain many possible questions: whether to act, which end to prioritize, which intervention to select, how much resource to commit, when to escalate, which threshold to use, whether to continue a pilot, or when to reopen deliberation. Each question constitutes a different decision object. Clarity at this level is essential because methods designed for one decision object can become misleading when transferred to another.

Definition 11.5 (Decision object). *A decision object is a bounded practical commitment to be selected, authorized, deferred, revised, or rejected among a specified set of reachable alternatives under an identified consequence structure, uncertainty profile, temporal horizon, and responsibility arrangement.*

A decision object contains more than alternatives. It includes the practical unit of commitment. A decision may concern a policy rule, an allocation, an intervention sequence, a trigger, a threshold, an institutional role, a continuation condition, or an exit pathway. The alternatives should therefore be formulated at the same practical level. Comparing a broad institutional transformation with a minor operational adjustment can create a misleading decision space if their scopes, horizons, and consequence structures differ substantially.

Decision objects also differ in temporal depth. Some are one-time commitments. Others are conditional or sequential. A provisional decision may authorize a first stage while reserving later stages for separate judgment. An adaptive pathway may specify several branches triggered by future observations. A method that treats a sequential decision as a one-time choice can obscure the value of learning and the preservation of options.

A decision object should therefore record its *commitment depth*: the degree to

which selecting an alternative commits resources, authority, institutions, relationships, expectations, or future options. Commitment depth is related to scale and irreversibility, although the concepts are distinct. A small intervention can create deep institutional lock-in, while a large temporary mobilization can remain comparatively reversible. The methodological representation should follow the actual structure of commitment.

Definition 11.6 (Decision-object profile). A *decision-object profile* records the practical commitment under consideration, admissible alternatives, consequence dimensions, affected positions, temporal horizon, commitment depth, uncertainty, authority, evidential requirements, residual disagreement, and revision or reopening conditions relevant to the decision.

The profile also distinguishes decision alternatives from scenarios. An alternative is something actors can select or authorize. A scenario is a possible state or trajectory under which an alternative can be examined. Conflating the two can produce an analysis in which imagined futures appear as controllable options or controllable interventions are treated as external conditions. Chapter 11 therefore develops scenario construction separately from decision analysis.

Decision objects can be nested. A collective may first decide whether a condition warrants intervention, then select among intervention families, then choose timing, scale, target, and implementation rules. Each nested decision can have different participants and evidential thresholds. A single comprehensive choice can sometimes simplify coordination, yet decomposition can improve revisability when uncertainty is high. The methodological architecture should make the decomposition explicit so responsibility does not disappear between decision stages.

Decision objects can also be contested. Actors may disagree about whether the relevant decision concerns immediate mitigation, long-term transformation, resource allocation, procedural legitimacy, or preservation of future options. Such disagreement concerns the constitution of the decision itself rather than merely the ranking of alternatives. A decision method should therefore permit revision of the decision object when the original formulation excludes a materially relevant commitment or affected position.

Definition 11.7 (Decision-object revision). *Decision-object revision* is a governed change to the scope, alternatives, consequence dimensions, horizon, authority, or commitment structure of a decision because the existing formulation no longer adequately represents the practical orientation or the situation in which commitment occurs.

Decision-object revision can occur before or after comparison begins. A method may reveal that all current alternatives violate an orientation constraint. Participation can disclose an omitted alternative. Historical analysis can show that the decision is framed at the wrong institutional level. Monitoring can reveal that the original object has been overtaken by changes in the situation. Revisability should therefore be designed into decision analysis rather than treated as evidence of methodological failure.

The decision object provides the unit around which decision methods are organized. It specifies what is being committed, compared, authorized, and potentially revised. The next subsection distinguishes this from the object of intervention, which concerns the configuration that praxis seeks to transform.

11.1.3 Intervention Objects

Decision and intervention are closely related but analytically distinct. A decision object concerns a commitment. An intervention object concerns what action is directed toward changing, sustaining, protecting, enabling, or constraining within the practical field. The distinction matters because one decision can authorize several interventions, and one intervention object can be approached through several different decisions and mechanisms.

Definition 11.8 (Intervention object). An *intervention object* is a specified condition, relation, capacity, constraint, institution, field configuration, rule, or generative process whose trajectory is intentionally addressed through practical action.

Intervention objects can be manifest or generative. A manifest intervention object may be an observable state requiring stabilization. A generative intervention object concerns the relations or conditions through which future states are produced. The distinction is important because changing a visible outcome can leave its generating relations largely intact, while changing a generative condition can produce delayed and distributed effects that are difficult to observe immediately.

The intervention object should therefore be represented at an appropriate depth. A recurring practical difficulty can be framed as an individual behavior, an interpersonal relation, an institutional routine, a structural constraint, an infrastructure, a distribution of capability, or a rule governing interaction. Each level suggests different methods and different risks. Chapter 11 later develops intervention target selection, scale selection, and intervention depth precisely because the intervention object should not be assumed from the first appearance of the practical problem.

Definition 11.9 (Intervention-object profile). An *intervention-object profile* records the target configuration, relevant relations and scales, hypothesized generative mechanisms, affected positions, enabling conditions, constraints, temporal dynamics, expected and unintended pathways, indicators of change, and conditions for adaptation, repair, or withdrawal.

The intervention-object profile creates a bridge between diagnosis and design. It should be sufficiently specific to support action while remaining revisable as implementation generates evidence. A target can change during intervention because the practical field responds. Actors adapt, institutions reorganize, capacities develop or erode, and new constraints become visible. The object of intervention can therefore be partly transformed by the intervention itself.

This reflexivity is especially important where the intervention changes categories, incentives, authority, or information. A measurement regime can alter behavior. A new institution can create actors whose later interests depend on the institution's continuation. A participatory process can generate collective agency that changes the implementation environment. A technical platform can reorganize dependencies. Methodological design should therefore distinguish between the intended intervention object and the broader relational changes generated through action.

Definition 11.10 (Intervention spillover field). An *intervention spillover field* is the set of materially relevant relations, positions, capacities, constraints, or institutional conditions altered by an intervention beyond the initially specified intervention object.

The spillover field should be monitored proportionately to consequence. It is rarely possible to observe every effect. The methodological task is to identify plausible path-

ways through which substantial distributed consequences could emerge and to maintain sufficient openness for unexpected effects to become visible. This is one reason intervention methodology requires interpretive, participatory, and historical forms of access alongside formal or quantitative monitoring.

An intervention object can also contain preservation as a legitimate practical aim. Intervention is sometimes associated with transformation, yet application-dominant praxis can seek to maintain a valuable capability, stabilize a fragile institution, preserve ecological or cultural continuity, protect a right, or prevent irreversible loss. In such cases the object is still intervention-relevant because action is directed toward sustaining a configuration against pressures that would otherwise alter it.

The relation between decision object and intervention object can now be specified more clearly. The decision object asks what commitment should be made under current conditions. The intervention object asks what configuration the commitment is intended to affect and through which practical pathways. A well-formed applied methodology keeps the two connected without conflating them.

Proposition 11.11 (Decision–intervention distinction). *An applied methodology gains practical clarity when the object of commitment and the object of transformation are specified separately and linked through an explicit account of mechanism, authority, implementation, and expected consequence.*

Proposition 11.11 prepares the later chapters on decision analysis and intervention design. It also provides the basis for method selection. Once the practical orientation, decision object, and intervention object are sufficiently explicit, methodological requirements can be identified with greater precision.

11.1.4 Method Selection

Method selection is the process of matching practical methodological requirements to procedures capable of performing them under real institutional and temporal conditions. The relevant comparison is broader than technical accuracy. A method may be analytically sophisticated yet poorly suited to the practical horizon, unavailable data, institutional capacity, participation requirements, reversibility needs, or responsibility structure of the situation. Conversely, a comparatively simple method can be appropriate when it performs the required function transparently, rapidly, and with adequate uncertainty discipline.

Method selection begins by specifying function. A practical methodology may need to reconstruct history, identify actors, map relations, estimate causal effects, explore scenarios, compare alternatives, elicit values, detect distributional consequences, monitor implementation, identify failure, or support adaptive revision. The function determines what counts as relevant methodological performance.

Definition 11.12 (Method-selection criterion). *A method-selection criterion is a practically relevant property used to assess whether a candidate method can perform a specified methodological function with adequate epistemic, temporal, institutional, participatory, and responsibility fit.*

Method-selection criteria can include evidential appropriateness, representational fit, temporal responsiveness, scalability, burden, transparency, contestability, interpretability, data requirements, implementation capacity, uncertainty representation, sensitivity to context, and compatibility with later revision. Their relative importance

depends on the practical object. A method used to trigger an emergency protective action may prioritize speed, conservative thresholds, and transparent failure modes. A method used to redesign a durable institution may require deeper historical reconstruction, broader participation, and stronger analysis of long-horizon consequences.

Method selection also includes the burden imposed by the method itself. Data collection can create privacy risks. Participation can demand time and emotional labor. Complex modelling can concentrate interpretive authority in a small technical group. Intensive monitoring can redirect organizational attention toward measured variables. An applied method is therefore part of the intervention environment and should be assessed for its own practical consequences.

Definition 11.13 (Method burden). A *method burden* is a materially relevant cost, exposure, dependency, exclusion, administrative demand, interpretive asymmetry, or opportunity cost generated by the use of an applied method itself.

Method burden can be justified when proportionate to the practical stakes, but it should remain visible. A method that produces highly precise estimates through a data regime that excludes important affected groups can distort the practical object even if the internal statistics are strong. A participatory process that repeatedly consults the same subjects without changing decision pathways can generate fatigue and distrust. A model that requires proprietary infrastructure can create future dependence on a vendor or expert community. These effects belong to method selection because they shape the practical field in which later action occurs.

Selection should also consider *method failure modes*. Every method has conditions under which its output becomes weak, misleading, or difficult to interpret. Historical analogy can overstate transferability. Statistical models can be unstable under distributional change. Optimization can embed disputed objectives. Deliberative methods can reproduce power asymmetries. Scenario methods can narrow imagination through the framing of plausible futures. Simulation can generate false confidence when assumptions are weakly identified. Method selection should identify characteristic failure modes early enough for complementary methods or safeguards to address them.

Definition 11.14 (Method-selection record). A *method-selection record* documents the methodological function, candidate methods considered, selection criteria, principal assumptions, expected burdens, characteristic failure modes, institutional feasibility, uncertainties, reasons for selection, and conditions under which the method should be supplemented, revised, or retired.

The method-selection record supports both accountability and learning. It enables later evaluators to reconstruct why a method was reasonable under the conditions available at the time. It also prevents a method from becoming institutionally entrenched merely because it was used previously. Repeated use can be justified by demonstrated fit, yet routine should not substitute for renewed assessment when the practical object changes.

Method selection is therefore a practical judgment under methodological uncertainty. Often several methods are defensible, each illuminating different aspects of the problem. The appropriate response is frequently a governed combination rather than a search for one comprehensive method. The next subsection develops the architecture of such combination.

11.1.5 Method Combination

Complex practical objects commonly exceed the reach of any single method. Historical formation, current relations, causal mechanisms, local meanings, future trajectories, institutional capacities, value conflicts, and implementation dynamics can require different modes of access. Method combination organizes these partially irreducible contributions while preserving their epistemic differences.

A combination is stronger when each method has a defined function. Adding methods without specifying their relation can generate volume without integration. Several methods may repeat the same assumptions, rely on the same data source, or reproduce the same institutional blind spot. Methodological plurality becomes practically valuable when it creates differentiated access, checks assumptions, reveals disagreement, or supports distinct stages of the applied lifecycle.

Definition 11.15 (Method-combination architecture). A *method-combination architecture* is a governed arrangement of two or more applied methods whose differentiated functions, sequence, interfaces, evidential relations, authority, and revision pathways are explicitly specified within a common practical orientation.

Method combinations can take several forms. Methods can be *sequential*, where one produces an input for another. They can be *parallel*, where several methods examine the same practical object through different representations. They can be *nested*, where a local method operates inside a broader design. They can be *iterative*, where outputs from one method revise the conditions of another. They can also be *adversarial* in a constructive sense, where different methods or teams are organized to challenge assumptions and identify failure conditions.

Combination requires interface discipline. A qualitative category can be translated into a quantitative variable, but the translation can narrow meaning. A simulation can use a historical estimate as a parameter, but the parameter may depend on a context that does not transfer. A participatory finding can modify an evaluation criterion, but the process through which voice becomes formal weight should remain explicit. Methodological interfaces are therefore sites at which practical meaning can change.

Definition 11.16 (Method-interface transformation). A *method-interface transformation* is a materially relevant change in representation, scale, category, uncertainty, evidential status, or practical function that occurs when an object or result moves from one applied method into another.

Method-interface transformations should be documented when they affect later judgment. A rich narrative converted into a binary indicator, a probability distribution converted into a threshold, or a stakeholder preference converted into an optimization weight can each alter practical meaning. The transformation can be useful and legitimate, yet its consequences should remain reconstructable.

Combination also creates the possibility of triangulation. Agreement among methods can increase confidence when their errors and assumptions are sufficiently independent. Agreement among methods sharing the same data and model assumptions provides weaker confirmation. Disagreement can be equally informative. A divergence between statistical estimates, local knowledge, and historical reconstruction may reveal scale mismatch, category instability, distributional heterogeneity, or a changing mechanism. Method combination should therefore preserve meaningful disagreement long enough to diagnose its source.

Definition 11.17 (Methodological disagreement). *Methodological disagreement* is

a materially relevant divergence among applied methods concerning description, mechanism, consequence, value, uncertainty, or practical implication that cannot be explained solely by superficial differences in presentation.

Methodological disagreement need not prevent action. It can alter the form of action. Deep disagreement about long-horizon consequences may support a reversible pilot rather than a full commitment. Divergence about affected positions may trigger additional participation. Conflicting causal accounts may justify monitoring designed to discriminate among mechanisms. Method combination thus connects directly to adaptive methodology.

The sequence of methods can itself shape the result. Beginning with a formal model can determine which variables later participants are asked to discuss. Beginning with participatory mapping can expand the categories entering later modelling. Historical reconstruction can shift the problem boundary before optimization begins. There is therefore no methodologically neutral ordering. Applied methodology should select sequence according to the practical orientation and record where ordering can materially influence the object.

Proposition 11.18 (Differentiated methodological integration). *Method combination is most informative when methods retain their differentiated epistemic functions, inter-face transformations are documented, and agreement or disagreement is interpreted in relation to the independence, scope, and assumptions of the contributing methods.*

This proposition preserves methodological pluralism without romanticizing plurality. More methods do not automatically yield better practical judgment. Combination should be proportionate to consequence and organized around functions the practical situation actually requires. The final subsection addresses how the resulting methodological architecture remains revisable as the situation changes.

11.1.6 Revisability of Applied Methods

Applied methods operate in changing fields. Evidence accumulates, categories shift, technologies change, institutions learn, actors adapt, values are reconsidered, and interventions alter the conditions they were designed to address. A method that initially fits a practical object can therefore become poorly calibrated even when it continues to operate exactly as designed. Methodological revisability is the capacity to detect and govern this change.

Definition 11.19 (Method revisability). *Method revisability* is the organized capacity to modify, supplement, replace, suspend, or retire an applied method when changes in the practical orientation, evidence, situation, implementation trajectory, institutional capacity, or observed consequences materially alter its fit.

Revisability begins with revision triggers. A trigger can arise from persistent prediction error, new affected positions, failure of an assumption, changed data-generating processes, implementation drift, emerging harm, institutional reorganization, technological change, or conflict between method outputs and observed practical consequences. Some triggers can be specified in advance, while others emerge through monitoring and contestation.

Definition 11.20 (Method revision trigger). *A method revision trigger* is a predefined or emergent condition indicating that the current method's assumptions, function, representation, burden, or practical consequences require structured reassessment.

Method revision should distinguish parameter updating from architectural change. A forecast model can be updated with new data while preserving its structure. A decision criterion can change its threshold while preserving the underlying value architecture. More substantial revision may replace the model class, redefine the outcome, broaden participation, alter the intervention object, or change the method's practical function. Recording the depth of revision helps preserve comparability across time.

Definition 11.21 (Applied method version). An *applied method version* is a temporally identified specification of a method's purpose, assumptions, data or evidential base, procedures, parameters, authority, safeguards, and interfaces that permits later reconstruction of which methodological configuration governed a practical judgment or intervention at a given stage.

Versioning is especially important for automated and adaptive systems. A model can change through retraining, data updates, prompt modification, software revision, or altered deployment rules while retaining the same public name. Without methodological versioning, later evaluation may attribute a consequence to a method whose actual operational configuration can no longer be reconstructed. The same issue appears in institutional routines whose informal practices evolve while formal documentation remains unchanged.

Revisability also has costs. Frequent methodological changes can weaken comparability, confuse responsibility, increase training burdens, and create instability. Institutions can become trapped between methodological inertia and methodological churn. A revisable architecture therefore requires continuity rules that identify which elements should remain stable long enough for learning and which can change rapidly in response to evidence.

Definition 11.22 (Method continuity rule). A *method continuity rule* specifies which components of an applied methodological architecture should remain stable across a defined horizon, which components can be updated, who can authorize changes, and how comparability and responsibility will be preserved through revision.

Methodological memory supports this balance. Institutions should retain records of prior method versions, reasons for change, failure signals, discarded alternatives, and consequences of revision. A method retired after poor performance can otherwise reappear later when organizational memory fades. Conversely, a useful method can be abandoned because the conditions under which it performed well are forgotten. Methodological memory turns revision history into an epistemic resource.

Revisability also includes recoupling with research. Some methodological problems exceed the capacity of embedded adaptation. Repeated model failure, unexplained heterogeneous effects, unstable categories, newly generated institutions, or persistent disagreement about mechanism can require a return toward research-dominant praxis. The applied method should preserve enough provenance, data lineage, practical context, and failure information for renewed inquiry to reconstruct the problem.

Definition 11.23 (Method recoupling condition). A *method recoupling condition* is a practical or epistemic development indicating that modification within the existing applied methodological architecture is insufficient and that a defined question should return toward research-dominant inquiry for deeper reconstruction.

The distinction between method revision and research recoupling prevents adaptive practice from absorbing every unresolved problem into local adjustment. Some

anomalies deserve systematic inquiry because they challenge the categories, mechanisms, or assumptions on which practical action depends. Preserving this route sustains the continuity between Parts III and IV while allowing application-dominant praxis to remain action-oriented.

Proposition 11.24 (Revisable methodological continuity). *An applied methodological architecture can remain both stable enough for responsibility and learning and revisable enough for changing practical conditions when method versions, revision triggers, continuity rules, interface changes, and research-recoupling conditions are explicitly governed and historically preserved.*

Proposition 11.24 completes the transition from applied praxis to method. Practical orientation specifies the direction and conditions of action. Decision objects identify bounded commitments. Intervention objects identify configurations toward which action is directed. Method selection connects methodological requirements to feasible procedures. Method combination coordinates partially irreducible forms of access and action. Revisability keeps the resulting architecture responsive to evidence, consequence, institutional change, and renewed inquiry.

The next methodological task is diagnosis. Before alternatives can be compared or interventions designed, the practical situation requires a structured reconstruction of actors, relations, constraints, capacities, histories, institutions, and uncertainty. Section 284 therefore develops practical diagnosis as the first major methodological family of Chapter 11.

11.2 Practical Diagnosis

Section 11.1 established the transition from practical orientation to organized method by distinguishing decision objects, intervention objects, method selection, method combination, and methodological revisability. The present section develops the first major methodological family required by that transition: practical diagnosis. Its role is to reconstruct the practical field before goals, criteria, epistemic-event and evidential architectures, alternatives, or interventions are specified in operational form. Its objective is to produce a disciplined and revisable account of the situation, actors, relations, constraints, capacities, historical formation, institutional configuration, and uncertainty that condition consequential action. The discussion proceeds through eight diagnostic movements: situation mapping, actor mapping, relation mapping, constraint mapping, capacity mapping, historical reconstruction, institutional diagnosis, and uncertainty mapping. The method is relational and reconstructive. It combines structured description with historical inquiry, positional comparison, institutional analysis, and explicit uncertainty recording while preserving the distinction between diagnosis, judgment, and intervention design.

Practical diagnosis performs a different function from problem formation in Chapter 10. Problem formation identifies a consequential configuration that has become practically salient and organizes it for judgment. Diagnosis asks how that configuration is constituted, reproduced, constrained, enabled, distributed, and historically formed. A problem can therefore be recognized before its diagnostic architecture is sufficiently developed. Conversely, diagnostic work can reveal that the original problem formulation is too narrow, uses unstable categories, omits affected positions, or mistakes a visible symptom for the relations that generate it. Diagnosis consequently

remains coupled to problem revision while retaining a distinct methodological function.

A practical diagnosis also differs from a comprehensive description of everything surrounding a problem. Application-dominant praxis operates under limited time, attention, capability, and evidence. Diagnostic work therefore requires scope discipline. The relevant question is which features of the practical field materially affect understanding of the problem, the reachable action space, the distribution of consequences, or the capacity for learning and revision. A diagnostic architecture can deepen when new evidence or implementation experience indicates that a previously backgrounded relation has become practically important.

Definition 11.25 (Practical diagnosis). A *practical diagnosis* is a structured and revisable reconstruction of the actors, relations, conditions, constraints, capacities, histories, institutions, and uncertainties that materially shape a practical problem, its reachable responses, and the consequences of action or inaction.

Definition 11.25 treats diagnosis as an applied methodological object rather than a one-time descriptive report. A diagnosis should identify its scope, standpoint, evidence base, temporal horizon, scale, unresolved uncertainty, and conditions for revision. It should also distinguish observed conditions from interpretive reconstruction and stronger generative claims. The same practical field can support several diagnostic representations when different questions, scales, or affected positions are relevant. Methodological discipline requires these differences to remain inspectable rather than being compressed into a single apparently neutral map.

Table 11.2 summarizes the eight diagnostic movements developed in this section. The table is a functional architecture rather than a mandatory sequence. Some practical situations require historical reconstruction before actor mapping; others begin with institutional boundaries or uncertainty. The diagnostic movements can therefore be iterated and reordered while their analytical functions remain distinguishable.

The architecture in Table 11.2 is deliberately relational. Situation mapping provides the diagnostic boundary; actor and relation mapping identify positions and connections; constraint and capacity mapping reconstruct the structure of practical possibility; historical and institutional analysis explain how that structure has formed and is reproduced; uncertainty mapping records the limits of the reconstruction. These components jointly produce a diagnosis that can support the subsequent specification of goals and criteria in Section 285 while remaining open to revision.

11.2.1 Situation Mapping

Situation mapping specifies the field to which the diagnosis refers. Chapter 10 defined a practical situation as a stage-, scale-, and standpoint-indexed relational configuration. The methodological task here is to make those indices explicit enough for later analysis. A situation map should identify the practical object, spatial or organizational boundary, temporal horizon, relevant scales, focal positions, material conditions, institutional interfaces, and major sources of change that define the current reconstruction.

Definition 11.26 (Situation map). A *situation map* is a bounded and revisable representation of the practical field that records the focal problem, relevant positions, material and institutional conditions, scales, temporal horizons, major relations, and

Table 11.2: Diagnostic architecture for application-dominant praxis

Diagnostic movement	Primary object	Characteristic question	Typical diagnostic risk
Situation mapping	Bounded practical field across positions, scales, and horizons	What configuration is being reconstructed for practical use?	Boundary compression, scale mismatch, and premature stabilization
Actor mapping	Persons, groups, organizations, collectives, and other practically relevant positions	Who can affect, experience, interpret, authorize, implement, maintain, or contest the practical trajectory?	Visibility bias, role conflation, and omission of weak or future positions
Relation mapping	Dependencies, exchanges, authority, information, care, conflict, coordination, and other consequential relations	Through which relations are effects generated, transmitted, amplified, or constrained?	Entity-centered description and unsupported causal attribution
Constraint mapping	Conditions that restrict, redirect, delay, price, or foreclose practical possibilities	Which conditions shape reachability and consequence across positions?	Treating constraints as fixed, uniform, or exclusively restrictive
Capacity mapping	Situated abilities to perceive, decide, coordinate, act, maintain, repair, learn, and revise	Which capacities exist, where are they located, and under what enabling conditions can they be mobilized?	Inferring capacity from resources, authority, or past output alone
Historical reconstruction	Sequences, inheritances, path dependencies, prior decisions, and accumulated consequences	How did the present practical configuration become reachable and persistent?	Presentism, retrospective inevitability, and excessive historical scope
Institutional diagnosis	Mandates, rules, roles, routines, interfaces, infrastructures, and organizational memory	How do durable arrangements enable, constrain, coordinate, and reproduce praxis?	Equating formal design with enacted institutional capacity
Uncertainty mapping	Epistemic, model, mechanism, implementation, value, and future-state uncertainty	What remains uncertain, why, for whom, and with what practical significance?	Single-score uncertainty and unrecorded ignorance

diagnostic boundary conditions used for applied analysis.

The boundary of a situation map is an analytical and practical choice. It can follow a neighborhood, organization, legal jurisdiction, infrastructure network, supply chain, ecological region, project boundary, or another relationally relevant unit. The boundary should be justified by the problem and mechanisms under investigation rather than by convenience alone. A formally available administrative boundary can be useful for authority and data while failing to contain the relations that generate the practical problem. Conversely, a very broad relational boundary can create analytical overload and weaken operational relevance. Situation mapping therefore requires a proportionate boundary that remains revisable when omitted relations become consequential.

A diagnostic boundary can be represented through a *core field* and one or more *interface fields*. The core field contains relations and conditions currently treated as central to the practical problem. Interface fields contain adjacent systems, institutions, populations, or environments through which important inputs, spillovers, constraints, or consequences may enter. This distinction allows diagnosis to retain focus while preserving pathways for boundary expansion.

Definition 11.27 (Diagnostic boundary profile). A *diagnostic boundary profile* records the core field, relevant interface fields, excluded domains, reasons for inclusion or exclusion, expected spillover pathways, and conditions that would require boundary revision.

Situation maps also require scale discipline. A pattern visible at one scale can obscure heterogeneity at another. Aggregate service availability can coexist with neighborhood exclusion. Organizational compliance can coexist with local implementation failure. A stable national indicator can coexist with rapidly changing subgroup expo-

sure. Diagnostic work should therefore state which scale each claim refers to and identify where cross-scale interactions are expected to matter.

Temporal boundaries require similar care. An immediate practical crisis can demand a short diagnostic horizon for stabilization while its generative conditions extend across years or decades. A long historical horizon can illuminate institutional formation while providing little guidance about an acute operational bottleneck. Situation mapping can therefore use several nested horizons: an immediate decision horizon, an implementation horizon, a structural horizon, and a historical horizon. Their relation should remain explicit because the significance of actors, constraints, capacities, and risks can change across time.

Standpoint is another constitutive dimension. Decision-makers, implementers, affected subjects, maintainers, and actors with exit capacity may inhabit different versions of the same practical field. A situation map can record these positional differences rather than choosing one as the uniquely authoritative view. Positional comparison can reveal that an arrangement experienced as efficient by one actor is experienced as inaccessible, risky, or burdensome by another. Such divergence is diagnostically important even before a normative judgment is made.

Situation mapping should also identify change processes already underway. A practical field is rarely static at the moment of diagnosis. Migration, technological adoption, institutional reform, ecological change, political turnover, market adjustment, infrastructure degradation, learning, conflict, or informal adaptation may be altering the conditions under which later methods will operate. A map that captures only a snapshot can therefore become obsolete before intervention begins. Recording directional change and known transition processes increases the usefulness of the diagnosis for later scenario and adaptive methods.

Proposition 11.28 (Revisable situational boundary). *A practical situation is most usefully mapped when its diagnostic boundary is explicit, proportionate to the practical object, sensitive to relevant scales and standpoints, and accompanied by conditions under which the boundary should be expanded, contracted, or re-indexed.*

Proposition 11.28 makes situation mapping a methodological commitment rather than a neutral prelude. Later actor, relation, constraint, and capacity maps inherit the boundary choices established here. Recording those choices supports revision when the diagnosis encounters evidence that its original field was too narrow or too broad.

11.2.2 Actor Mapping

Actor mapping identifies the positions whose agency, exposure, knowledge, authority, dependence, contribution, or contestation materially affect the practical trajectory. The term *actor* is used functionally in this subsection. It can include individuals, households, professional groups, organizations, agencies, communities, firms, networks, coalitions, technical systems with delegated operational roles, or other positions through which consequential action is organized. The map should preserve distinctions among actors rather than assuming a single unitary form of agency.

Definition 11.29 (Practical actor map). *A practical actor map is a structured representation of the positions that can materially affect, experience, interpret, authorize, implement, maintain, resist, contest, or revise a practical trajectory, together with their relevant roles, resources, capacities, dependencies, and exposure.*

Actor mapping begins with role differentiation. Chapter 10 distinguished affected subjects, stakeholders, participants, representatives, and decision-holders. Practical diagnosis adds implementers, maintainers, monitors, evaluators, intermediaries, infrastructure providers, knowledge holders, gatekeepers, beneficiaries, risk bearers, and actors whose cooperation or refusal materially changes the action space. A single person or institution can occupy several roles, and the same role can be distributed across several actors. The diagnostic task is therefore to map role configuration rather than merely list organizational names.

Visibility creates a recurring bias. Actors with formal authority, abundant data, technical expertise, or organizational resources are easier to identify. Actors who experience diffuse burdens, possess local knowledge, lack recognized representation, operate informally, or enter only at later stages can remain absent. Future maintainers and future affected positions are especially easy to omit because they are not present during initial diagnosis. Actor mapping should therefore include an explicit search for low-visibility positions whose practical relevance exceeds their current institutional visibility.

Definition 11.30 (Actor visibility gap). An *actor visibility gap* is a diagnostically relevant difference between an actor's practical significance and the degree to which that actor is represented in the available data, institutional process, formal authority structure, or current problem formulation.

A practical actor map should also record positional attributes without turning them into fixed identities. Relevant attributes can include decision authority, implementation responsibility, access to information, exposure to risk, capacity to wait, ability to exit, dependence on infrastructure, technical expertise, social trust, legal standing, or access to remedial pathways. Their relevance depends on the practical object. Mapping should therefore remain selective and purpose-linked.

Actor maps benefit from distinguishing direct, indirect, and conditional relevance. Direct actors participate in or experience the focal practical process. Indirect actors shape enabling conditions, supply resources, establish rules, or absorb spillovers. Conditional actors become relevant when particular scenarios, thresholds, failures, or escalation pathways occur. This distinction is useful for emergency arrangements in which dormant authority or backup capability becomes important only under defined conditions.

Actors can also change through the practical process. An affected group can organize and become a collective decision participant. A technical vendor can gain infrastructural power as dependence deepens. A local intermediary can become a central knowledge broker. A regulator can shift from oversight to direct intervention after threshold breach. Actor mapping should therefore record plausible role transitions rather than treating the field as institutionally frozen.

Agency should be distinguished from formal authority. A formally subordinate actor can possess substantial practical agency through expertise, network centrality, refusal capacity, local legitimacy, or control over indispensable infrastructure. An actor with formal authority can possess weak effective agency because of resource scarcity, fragmented jurisdiction, low trust, or implementation dependence. Actor mapping should therefore be linked to relation, constraint, and capacity maps before conclusions about practical power are drawn.

Definition 11.31 (Actor-role profile). An *actor-role profile* records an actor's relevant practical roles, authority, exposure, knowledge position, dependencies, capacities,

participation pathways, exit conditions, and plausible role transitions within a specified diagnostic field.

Actor mapping also supports later participation design. The presence of an actor on a diagnostic map does not by itself determine that actor's decision right or participatory status. It establishes practical relevance that can inform later judgments about representation, consultation, authority, accountability, and contestability. Keeping diagnosis separate from allocation of decision rights prevents the actor map from becoming an implicit governance decision.

The map should preserve uncertainty about actor boundaries where collective identity is unsettled. Communities, networks, organizations, and coalitions often contain internal disagreement. Treating them as homogeneous can erase minority positions or hidden role differences. Actor mapping can therefore use nested representation: the collective can appear as a practical actor while internal subpositions remain visible when they materially affect diagnosis.

Proposition 11.32 (Role-sensitive actor diagnosis). *Actor mapping is diagnostically stronger when practical relevance, role configuration, visibility, effective agency, and internal heterogeneity are recorded separately from formal status or nominal membership.*

This proposition prepares relation mapping. Actors become practically intelligible through the relations that connect them. The next diagnostic movement therefore shifts attention from positions to the structures through which authority, information, resources, dependence, care, conflict, and consequences travel.

11.2.3 Relation Mapping

Relation mapping reconstructs the connections through which the practical field is generated and maintained. An entity list can identify who is present while leaving unexplained how effects propagate, why some actors depend on others, where coordination fails, or how institutional power is converted into practical consequence. Relation mapping therefore treats dependencies, exchanges, authority, information, care, trust, conflict, coordination, representation, maintenance, and material flows as diagnostic objects in their own right.

Definition 11.33 (Practical relation map). *A practical relation map is a structured representation of consequential relations among practical positions, including the direction, content, strength, conditions, asymmetry, temporal pattern, and uncertainty of those relations where these properties are relevant to the diagnosis.*

A relation map should specify what is related. A connection can concern authority, information, finance, material resources, technical dependency, care, obligation, recognition, trust, representation, conflict, data, maintenance, legal responsibility, or another practical object. Using a single undifferentiated edge between actors can hide major differences in mechanism. A relationship of information dependence can coexist with legal autonomy; a relationship of financial support can coexist with weak operational influence; a relationship of formal supervision can coexist with strong implementation dependence in the reverse direction.

Direction also matters. Some relations are reciprocal, while others are strongly asymmetric. Information can flow from local implementers to a central authority while decisions flow in the opposite direction. Maintenance obligations can flow to-

ward one actor while benefits are distributed elsewhere. Risk can be imposed downstream while authority remains upstream. Recording direction helps diagnose where responsibilities, consequences, and capabilities become separated.

Relation mapping should also identify interfaces. Practical failure frequently occurs at interfaces between otherwise competent units. Information can be lost between agencies, standards can be incompatible across technical systems, responsibility can fall between organizational mandates, or an intervention can require cooperation from an actor whose incentives were never considered. An interface is therefore more than a boundary; it is a place where translation, transfer, coordination, or joint action must occur.

Definition 11.34 (Practical interface). A *practical interface* is a relational site at which information, authority, resources, responsibility, interpretation, technical outputs, or coordinated action must pass between positions, systems, or institutional domains for a practical process to function.

Interfaces can be robust, fragile, redundant, contested, or absent. Their quality can matter more than the average capacity of the participating actors. A high-capacity institution can fail when its outputs cannot be used by downstream actors. A technically sound monitoring system can remain practically inert if there is no interface linking warning signals to authorized response. Interface diagnosis should therefore record translation rules, latency, redundancy, escalation pathways, and failure modes where these features are consequential.

Relational asymmetry requires careful interpretation. Unequal authority, information, resources, or exit capacity can generate practical power when conversion conditions permit. Relation mapping can identify such asymmetries while leaving normative evaluation to later sections. It can also reveal countervailing relations: formal hierarchy can be moderated by professional norms, legal review, reputational dependence, or technical reliance on subordinate actors. The map should represent effective relational structure rather than assume that one formal hierarchy explains the whole field.

Relations can be multiplex. The same two actors can cooperate in one domain, compete in another, exchange information, share infrastructure, and hold mutual legal obligations. Multiplex relations can create resilience through redundancy or fragility through coupled dependence. Diagnostic representations should therefore preserve relation type when collapsing several relations would obscure practical mechanism.

Temporal pattern is similarly important. Some relations are continuous; others activate during crisis, contract renewal, maintenance cycles, elections, budget periods, seasonal change, or threshold events. A dormant emergency coordination relation can become decisive during failure. Relation mapping can record activation conditions so later scenario and adaptive methods know which connections are expected to become operative under changing conditions.

A relation map should also distinguish observation from generative interpretation. Repeated co-occurrence or communication does not by itself establish a mechanism. Diagnostic work can propose a relational hypothesis while recording the evidence and alternatives that support it. This is especially important when relation maps are generated from digital traces, network data, organizational charts, or interview accounts whose representational limits differ.

Definition 11.35 (Relational diagnostic claim). A *relational diagnostic claim* is an evi-

dentially bounded proposition concerning how a specified relation contributes to the reproduction, transmission, amplification, inhibition, or transformation of a practical condition.

Relational diagnostic claims can be weak or strong. A weak claim may identify a repeated dependency or communication pathway. A stronger claim may propose that the relation generates a bottleneck, reinforces an institutional pattern, or transmits risk. Stronger claims require correspondingly stronger evidence and should remain revisable when implementation produces new traces.

Proposition 11.36 (Relational diagnostic priority). *When practical consequences depend materially on coordination, dependence, transmission, authority, or interface conditions, diagnosis should represent those relations explicitly rather than infer the practical field from actor attributes alone.*

Relation mapping provides the basis for the next two diagnostic movements. Constraints and capacities are frequently relational properties: a condition can constrain one actor while enabling another, and a capacity can depend on access to other actors, institutions, infrastructure, or trust. Their maps should therefore remain linked to the relational architecture developed here.

11.2.4 Constraint Mapping

Constraint mapping identifies the conditions that restrict, redirect, delay, increase the cost of, or foreclose practical possibilities. Chapter 10 treated constraints as constitutive elements of the action space. The methodological task is to locate them, identify the positions and pathways through which they operate, and distinguish their current effects from assumptions about their permanence.

Definition 11.37 (Practical constraint map). *A practical constraint map is a structured representation of conditions that materially limit, redirect, delay, price, condition, or foreclose practical actions, together with their affected positions, activation conditions, temporal persistence, relational pathways, and degree of modifiability where these can be established.*

Constraints can be material, institutional, legal, informational, technological, organizational, financial, temporal, ecological, cultural, relational, or capability-based. The categories are analytical aids rather than mutually exclusive types. A legal requirement can become a temporal constraint through lengthy procedure; a technical standard can become an institutional constraint when procurement depends on it; a social norm can become a coordination constraint when actors expect sanction for deviation. Constraint mapping should therefore record how a constraint operates rather than assign it only to a category.

A useful distinction concerns hard, soft, and contingent constraints. A hard constraint is treated as effectively fixed within the relevant practical horizon, such as a physical limit or binding legal prohibition that cannot realistically be altered before the decision. A soft constraint can be changed through feasible resource, coordination, institutional, or design adjustments. A contingent constraint applies only under specified conditions, scenarios, or actor configurations. This classification should remain horizon-sensitive: a constraint hard in an emergency horizon can become soft over institutional reform time.

Definition 11.38 (Constraint modifiability profile). *A constraint modifiability profile*

records the practical horizon, actors, resources, authority, dependencies, and conditions under which a diagnosed constraint can plausibly remain fixed, be relaxed, be bypassed, be transformed, or be removed.

This profile prevents a common diagnostic error in which historically produced constraints are treated as natural facts. Institutional rules, organizational routines, infrastructure arrangements, category systems, and resource distributions can acquire the appearance of necessity because they have persisted. Historical reconstruction can reveal that their current form is contingent and potentially transformable, even when rapid change remains impractical.

Constraints are also positional. A requirement can impose little burden on a large organization while effectively excluding a small group. A digital procedure can reduce administrative cost for one institution while increasing access barriers for users with limited connectivity. A standardized schedule can improve coordination while constraining actors with care responsibilities. Constraint maps should therefore record distribution rather than assume uniform effect.

Constraints can interact. Several individually manageable conditions can combine into a binding configuration. Limited authority, fragmented information, and short decision time can jointly make a response unreachable even when each element alone appears moderate. Diagnostic work should therefore search for constraint bundles and threshold effects rather than only rank isolated barriers.

Definition 11.39 (Constraint configuration). A *constraint configuration* is a set of interacting constraints whose combined effect on practical reachability or consequence differs materially from the effect expected from considering each constraint separately.

The same condition can also function as an enabling constraint. Rights protections, safety standards, ecological limits, audit requirements, and procedural safeguards can restrict immediate action while preserving legitimacy, reliability, or future options. Constraint mapping should therefore describe function before normative evaluation. Later goal and criterion specification can determine whether the constraint should be preserved, modified, or treated as a design requirement.

Constraint maps should also identify who bears the cost of compliance and who has the capacity to modify the constraint. This information links diagnosis to power and justice without resolving those normative questions inside the diagnostic stage. A rule that appears equally binding can generate unequal effective action spaces when actors differ in resources, time, expertise, or access to exception procedures.

The relation between constraints and intervention objects is especially important. Some practical projects target a visible outcome while leaving the constraints that reproduce it unchanged. Others attempt to remove a constraint while overlooking the functions it currently performs. Diagnosis should therefore distinguish symptom-level restrictions from generative constraints and record plausible consequences of altering them. A constraint map can identify candidate intervention objects while leaving target selection to Section 297.

Proposition 11.40 (Constraint diagnosis and reachability). A *diagnosed constraint becomes practically informative when its affected positions, operating pathway, temporal horizon, interactions, and modifiability are sufficiently specified to explain how it changes the reachability or consequence of relevant actions.*

Constraint mapping naturally pairs with capacity mapping. Practical possibility

is shaped jointly by what restricts action and what enables actors or institutions to perceive, coordinate, act, sustain, repair, and revise. The next subsection therefore reconstructs the enabling side of the action space.

11.2.5 Capacity Mapping

Capacity mapping identifies the situated abilities through which actors and institutions can perform practical functions. Capacity is neither a stock of resources nor a record of past output. A capacity exists through enabling configurations that can include knowledge, authority, relationships, infrastructure, routines, time, trust, material resources, and access to complementary capabilities. The diagnostic task is to identify which capacities matter, where they are located, how they can be mobilized, and how durable they are under practical demand.

Definition 11.41 (Practical capacity map). A *practical capacity map* is a structured representation of the situated abilities required to perceive, interpret, decide, coordinate, act, maintain, monitor, repair, learn, and revise within a practical field, together with their carriers, enabling conditions, dependencies, activation costs, limits, and signs of depletion or development.

Capacity mapping should begin from function. A project can require diagnostic capacity, decision capacity, implementation capacity, coordination capacity, maintenance capacity, monitoring capacity, repair capacity, participatory capacity, or learning capacity. Treating these as one general organizational capability can hide important gaps. An institution can make high-quality decisions while lacking implementation reach; it can implement rapidly while lacking monitoring and repair; it can collect data while lacking interpretive capacity to use them.

Resources contribute to capacity when conversion conditions are present. Funding without procurement capability may remain unusable. Expertise without authority can remain advisory. Legal authority without staff, information, or trust can remain nominal. Infrastructure without maintenance can deteriorate. Capacity mapping should therefore identify conversion pathways linking resources and institutional positions to effective practical ability.

Definition 11.42 (Capacity activation pathway). A *capacity activation pathway* is the set of enabling relations, resources, permissions, competencies, infrastructures, and coordination conditions through which a latent or nominal capability becomes practically deployable for a specified function.

Activation pathways can reveal bottlenecks that are invisible in resource inventories. A trained team may require data access controlled elsewhere. A local organization may possess contextual knowledge but lack a recognized interface with decision-makers. A technical system may have analytical capability while lacking a legal basis for operational use. Diagnosis should therefore connect capacity maps with actor and relation maps.

Capacity is also distributed. Collective capacity can arise from complementary positions whose individual abilities are insufficient alone. Emergency response can depend on coordination among sensing, communication, transport, medical, and authorization functions. Institutional learning can depend on front-line observation, archival memory, analytical expertise, and management authority. Capacity mapping should represent the configuration through which these functions combine rather than sum individual attributes.

Definition 11.43 (Collective capacity configuration). A *collective capacity configuration* is an organized set of complementary abilities, relations, interfaces, and enabling conditions whose coordination permits a practical function that the participating positions could not reliably perform in isolation.

Latent capacity is diagnostically important. Actors can possess abilities that are currently inactive because coordination, authority, trust, resources, or recognition are absent. A crisis can activate dormant networks; a new interface can make local expertise usable; a policy change can unlock previously unavailable institutional capacity. Diagnosis can record plausible latent capacities where there is evidential support for the activation pathway. Speculative possibility should remain distinguished from practically supportable latent capacity.

Capacity can also be depleted. Intensive implementation can consume staff attention, trust, financial reserves, maintenance slack, political legitimacy, or informal cooperation while short-run output remains high. A capacity map should therefore include sustainability and recovery where the practical horizon extends beyond immediate delivery. High current performance can coexist with declining future capacity.

Definition 11.44 (Capacity sustainability profile). A *capacity sustainability profile* records the resources, relationships, maintenance, renewal, workload, learning, and recovery conditions required for a practical capacity to persist across the relevant horizon.

This profile is especially important for interventions that rely on extraordinary effort. A pilot can succeed because a small team supplies exceptional attention that cannot be maintained at scale. An emergency arrangement can function temporarily while accumulating deferred maintenance. Diagnostic work should therefore distinguish demonstrated capacity under current conditions from scalable and sustainable capacity.

Capacity maps can also identify asymmetry. Actors can differ in capacity to wait, absorb loss, interpret technical information, organize collectively, navigate institutions, or exit. These differences shape the effective action space and later participation. Diagnosis records the asymmetry without yet deciding what justice requires.

Finally, capacity is endogenous to praxis. Interventions can build, erode, redistribute, or lock in capabilities. A practical diagnosis therefore provides a baseline for later evaluation of capacity change. It can also reveal that capacity generation itself may become an intervention object. Section 297 will address target selection more directly; the present task is to make the existing capacity architecture visible.

Proposition 11.45 (Capacity conversion discipline). *Capacity should be attributed to a practical position when a specified function, enabling configuration, and plausible activation pathway can be identified, with relevant dependencies, limits, and sustainability conditions recorded where they materially affect practical use.*

The relation between present capacity and earlier formation leads to historical reconstruction. Capacities, constraints, relations, and institutional arrangements are products of prior trajectories whose reconstruction can explain why the current field possesses its present structure.

11.2.6 Historical Reconstruction

Historical reconstruction identifies the sequences through which the present practical field became reachable, persistent, and interpretable. Its function is diagnostic rather than antiquarian. The objective is to explain current relations, constraints, capacities, institutions, and expectations where their practical significance depends on inherited decisions, path dependencies, accumulated consequences, prior crises, classification systems, or institutional learning.

Definition 11.46 (Practical historical reconstruction). A *practical historical reconstruction* is a problem-oriented account of the sequences, decisions, contingencies, institutional changes, accumulated effects, and inherited interpretations through which a present practical configuration acquired materially relevant features.

The appropriate historical depth depends on the object. An equipment failure can require reconstruction of maintenance history, procurement, and recent operating conditions. A persistent institutional disparity can require examination of earlier rules, exclusions, infrastructures, and value classifications. A coordination failure can arise from an organizational merger whose incompatible procedures remain embedded years later. Historical reconstruction should therefore select depth according to the generative pathways that remain active in the present.

A useful diagnostic distinction separates historical antecedence from historical carryover. Many past events precede the present condition, while only some continue to shape it through identifiable pathways. A practical historical account should therefore trace the relation through which an earlier decision or condition persists: infrastructure, legal rule, institutional memory, debt, expectation, skill distribution, category, ownership structure, trust, stigma, or another durable carrier.

Definition 11.47 (Historical carryover pathway). A *historical carryover pathway* is a reconstructable relation through which an earlier event, decision, institution, classification, investment, conflict, or consequence continues to shape a present practical condition.

This definition guards against two opposing errors. Presentism treats the current field as if it were produced only by contemporary choices. Retrospective overreach attributes current outcomes to distant history without identifying a continuing mechanism. Historical diagnosis should connect past and present through evidence of persistence, transformation, or inherited constraint.

Historical reconstruction should also preserve contingency. Current arrangements can appear inevitable once they have stabilized. Yet earlier actors often faced several reachable alternatives, incomplete knowledge, and competing values. Reconstructing those alternatives can reveal path dependence, lock-in, and lost capacities while resisting retrospective certainty. It can also identify moments when intervention changed the set of later possibilities.

Institutional memory provides one source for this reconstruction, but official records can be selective. Archives, policy documents, technical logs, budgets, correspondence, prior evaluations, oral testimony, local memory, and material traces can provide complementary access. Their evidential statuses differ. A practical historical reconstruction should record where the account rests on official records, experiential testimony, inference, or later reinterpretation.

Historical categories require caution. Terms used in earlier periods can differ from current analytical categories. Reclassifying the past through current concepts can

make comparison possible while introducing distortion. Diagnostic history should therefore distinguish actor categories used at the time from present analytical categories where the difference matters. This supports the broader book principle that concepts themselves have histories.

Historical reconstruction can also reveal repeated intervention patterns. Institutions may repeatedly respond to symptoms while leaving generative constraints intact. A policy cycle may alternate between centralization and decentralization. Maintenance may be deferred until crisis. Participation may expand during reform and contract during implementation. Identifying such recurrent structures can inform later scenario construction and robustness analysis without assuming that history repeats mechanically.

Definition 11.48 (Practical path record). A *practical path record* is a structured account of materially relevant turning points, contingencies, commitments, carryover pathways, lost alternatives, accumulated consequences, and prior adaptations that help explain the present practical configuration.

Historical reconstruction also changes responsibility analysis. Present actors can inherit conditions they did not create while possessing varying capacities to maintain, repair, or transform them. Diagnosis should therefore separate origin, inheritance, current control, and current response capacity. Later sections can use this distinction when specifying goals, criteria, responsibility, and justice.

Proposition 11.49 (Historical diagnostic relevance). *Historical material is diagnostically relevant when it clarifies a continuing relation, inherited condition, path dependence, institutional memory, capacity, constraint, or expectation that materially affects the current practical field or its reachable transformations.*

The historical record often converges on institutions as durable carriers of earlier decisions and present capacities. The next subsection therefore reconstructs the enacted institutional configuration through which practical action is authorized, coordinated, remembered, constrained, and revised.

11.2.7 Institutional Diagnosis

Institutional diagnosis examines the durable arrangements through which praxis is organized. Chapter 10 developed mandates, capacity, constraints, memory, collective decision, coordination, cooperation, conflict, trust, and collective generativity as dimensions of institutional praxis. The methodological task here is to reconstruct how those dimensions operate in the present practical field, with particular attention to divergence between formal design and enacted practice.

Definition 11.50 (Institutional diagnosis). An *institutional diagnosis* is a structured and revisable reconstruction of the mandates, roles, rules, routines, infrastructures, decision rights, interfaces, capacities, constraints, memory, accountability pathways, and informal practices through which a practical field is organized and reproduced.

Institutional diagnosis begins with mandate and authority. Formal mandates define recognized responsibilities and permissions, while actual practice can distribute influence differently. Overlapping mandates can create conflict or redundancy; mandate gaps can leave important practical objects without a responsible institution; broad mandates can exceed available capacity; narrow mandates can prevent actors from addressing cross-boundary problems. Diagnosis should therefore map the

relation between formal mandate, practical authority, and operational reach.

Rules also require an enacted perspective. Written procedure can differ from routine implementation because of workload, informal adaptation, local interpretation, technological systems, professional norms, or resource constraints. Institutional diagnosis should identify where formal rules are decisive, where discretion operates, and where workarounds have become stable parts of the system. Such workarounds can increase resilience while also hiding structural mismatch.

Definition 11.51 (Enacted institutional configuration). An *enacted institutional configuration* is the practically operative arrangement of formal rules, informal routines, infrastructures, role expectations, discretionary practices, resource flows, and relational dependencies through which institutional action is actually produced.

Decision architecture is another diagnostic object. The relevant questions include who can place issues on the agenda, who supplies evidence, who interprets it, who can authorize commitment, who implements, who can suspend action, who monitors, who evaluates, and who can reopen the decision. Mapping only the final decision-maker can obscure substantial upstream and downstream power.

Interfaces deserve special attention. Institutional fields frequently depend on handoffs across agencies, departments, professional groups, jurisdictions, contractors, or technical systems. A mandate can be clear within each unit while responsibility for the interface remains ambiguous. Institutional diagnosis should therefore search for interface gaps, duplicate authority, translation burdens, incompatible data standards, escalation failures, and unclear maintenance responsibility.

Institutional capacity should be reconstructed through enacted function rather than formal resource inventories alone. Staff, budgets, legal authority, technology, procedures, and expertise become capacity when they can be coordinated toward practical tasks. Diagnosis can compare mandate requirements with demonstrated and latent capacities, identifying where the institution is overextended or where unrecognized capability exists.

Institutional memory is similarly practical. Archives, databases, manuals, professional experience, long-standing relationships, and routines can preserve knowledge across time. Memory becomes fragile when personnel turnover, outsourcing, incompatible information systems, organizational restructuring, or undocumented workarounds break continuity. Institutional diagnosis should identify what knowledge is retained, where it resides, how it can be retrieved, and whether it remains connected to decision and revision pathways.

Accountability architecture should also be mapped diagnostically. Reporting obligations, audit, legal review, professional discipline, public scrutiny, grievance systems, appeals, internal review, and informal norms can create different forms of answerability. Their presence does not guarantee effective accountability. Diagnosis should record whether a pathway can receive a concern, investigate it, require response, authorize correction, and preserve a record. A nominal complaint mechanism with no practical remedy performs a different function from a contestability pathway linked to decision revision.

Trust and legitimacy can affect institutional capacity. Low trust can reduce reporting, cooperation, compliance, or participation even when formal authority is strong. High trust can facilitate coordination while also weakening scrutiny if expectations become insufficiently calibrated. Institutional diagnosis can record trust relations

where they materially affect the operation of procedures or the willingness of actors to rely on institutional commitments.

Institutional diagnosis should also identify self-revision capacity. Some institutions can detect failure, preserve dissent, compare outcomes, modify procedures, and redistribute authority. Others reproduce established arrangements despite changing conditions. This capacity matters for adaptive methodology because later monitoring and evaluation are useful only when institutions possess a pathway through which learning can alter action.

Definition 11.52 (Institutional revision capacity). *Institutional revision capacity* is the enacted ability of an institutional configuration to detect materially relevant mismatch, preserve and interpret evidence, contest existing arrangements, authorize change, implement revision, and maintain sufficient continuity for responsibility and learning.

Institutional diagnosis can therefore reveal both intervention opportunities and intervention limits. A technically appropriate design can fail if it assumes authority, coordination, maintenance, or learning capacity that the institution does not possess. Conversely, institutional strengths can support interventions that would appear infeasible from a resource-only perspective.

Proposition 11.53 (Formal-enacted institutional distinction). *Institutional diagnosis should distinguish formal mandates, rules, and structures from enacted roles, routines, interfaces, capacities, and accountability pathways whenever divergence between them can materially alter practical consequence.*

The institutional reconstruction remains incomplete without an explicit account of uncertainty. Every map developed in this section is based on partial evidence, interpretive choices, changing conditions, and unresolved mechanisms. The final subsection therefore makes uncertainty part of the diagnosis itself.

11.2.8 Uncertainty Mapping

Uncertainty mapping records the limits of the practical diagnosis and the practical significance of those limits. The objective is broader than attaching confidence intervals to quantitative estimates. Practical uncertainty can concern missing actors, unstable categories, disputed relations, unknown mechanisms, future institutional behavior, implementation variability, value disagreement, data quality, model structure, or possible states that have not yet been imagined. These forms of uncertainty influence method selection, decision thresholds, participation, monitoring, and the reversibility of later commitments.

Definition 11.54 (Diagnostic uncertainty map). A *diagnostic uncertainty map* is a structured representation of materially relevant unknowns, ambiguities, contested interpretations, model limitations, evidential gaps, and future contingencies, together with their location in the diagnosis, practical significance, affected positions, and possible pathways for learning or protection.

A useful uncertainty map distinguishes several forms. *Observational uncertainty* concerns measurement, missing data, sampling, reporting, or access. *Representational uncertainty* concerns categories, boundaries, proxies, and model structure. *Mechanism uncertainty* concerns how observed relations generate outcomes. *Implementation uncertainty* concerns how action will be enacted across contexts and actors.

Behavioral or strategic uncertainty concerns adaptation, resistance, cooperation, or gaming. *Future-state uncertainty* concerns external changes in technology, institutions, environment, or demand. *Normative uncertainty* concerns unresolved values, thresholds, standing, or priority rules. These forms can overlap while supporting different methodological responses.

Definition 11.55 (Uncertainty location). An *uncertainty location* is the diagnostic component—actor, relation, constraint, capacity, history, institution, category, mechanism, value, or future condition—within which a materially relevant uncertainty enters the practical analysis.

Locating uncertainty prevents a single global confidence statement from obscuring where the diagnosis is fragile. High confidence in actor identification can coexist with low confidence in causal mechanism. A well-measured current state can coexist with deep uncertainty about future adaptation. A technically precise model can coexist with contested normative thresholds. Different uncertainty locations can therefore imply different responses.

Uncertainty should also be ranked by practical relevance rather than epistemic curiosity alone. Some unknowns have little effect on the set of acceptable actions; others determine whether an intervention could create serious harm. A diagnostic process can use *decision relevance* to prioritize further inquiry. This does not require the decision itself to be fixed in advance. It requires a provisional understanding of which uncertainties could materially alter practical judgment, action-space reachability, risk distribution, or reversibility.

Definition 11.56 (Decision-relevant diagnostic uncertainty). A *decision-relevant diagnostic uncertainty* is an uncertainty whose plausible resolution could materially change the formulation of the practical problem, the set or ranking of reachable actions, the distribution of consequences, the required safeguards, or the conditions for provisional closure.

Uncertainty mapping should identify learning pathways where available. Additional measurement can reduce observational uncertainty. Comparative analysis can test category stability. Historical reconstruction can clarify path dependence. Participation can reveal omitted actors or values. Pilots can generate implementation evidence. Monitoring can track evolving conditions. Formal sensitivity analysis can test parameter dependence. Some uncertainty, however, cannot be reduced within the relevant horizon. It may require robust action, option preservation, staged commitment, protective thresholds, or explicit residual uncertainty carriage.

Ignorance deserves a place in the diagnostic architecture. Known unknowns can be recorded directly, while unknown unknowns are harder to represent. Practical diagnosis can nevertheless create conditions for discovering them: preserving dissent, maintaining open reporting channels, including heterogeneous standpoints, monitoring unexpected outcomes, and avoiding overly rigid categories. An uncertainty map can therefore record *ignorance-sensitive interfaces* where novel information is most likely to emerge.

Definition 11.57 (Ignorance-sensitive interface). An *ignorance-sensitive interface* is a monitoring, participatory, institutional, or observational pathway designed to increase the probability that materially relevant unanticipated conditions or consequences can become visible to the practical process.

Uncertainty is also distributed. Decision-makers can be uncertain about local ex-

perience while affected subjects possess strong situated knowledge. Front-line actors can recognize implementation fragility that central institutions underestimate. Technical experts can understand model uncertainty that political authorities or the public do not see. A diagnostic uncertainty map should therefore record whose uncertainty and whose knowledge are being represented. Apparent uncertainty can sometimes be a problem of disconnected knowledge rather than absence of knowledge.

The map should preserve disagreement where interpretations differ. Two diagnostic teams can agree on observations while disagreeing about mechanism. Actors can agree on mechanism while disagreeing about future behavior or normative significance. Recording the location and basis of disagreement helps later method combination and participatory decision design. Forcing premature consensus can hide uncertainty that matters for robust or adaptive action.

Diagnostic uncertainty also changes through time. Evidence can reduce one uncertainty while intervention generates another. A pilot can clarify implementation while revealing new relational dependencies. Institutional reform can reduce mandate ambiguity while creating transition risk. Uncertainty mapping should therefore be versioned alongside the diagnosis.

Definition 11.58 (Diagnostic revision record). A *diagnostic revision record* documents materially relevant changes in the situation, actor, relation, constraint, capacity, historical, institutional, or uncertainty maps, together with the evidence, practical event, or interpretive reason that motivated revision.

The diagnostic revision record turns diagnosis into a maintained methodological object. It also supports accountability: later actors can reconstruct which practical field was believed to exist at a given time and how that belief changed. This is especially important when evaluation occurs after conditions have shifted substantially.

Proposition 11.59 (Uncertainty-explicit diagnosis). A *practical diagnosis* is methodologically stronger when materially relevant uncertainty is located within specific diagnostic components, linked to its practical significance, and connected where possible to learning, protection, monitoring, or revision pathways.

The eight diagnostic movements developed in this section jointly produce a revisable reconstruction of the practical field. Situation mapping specifies the field; actor and relation mapping identify positions and consequential connections; constraint and capacity mapping reconstruct the structure of practical possibility; historical and institutional diagnosis explain how that structure has formed and is reproduced; uncertainty mapping records the limits and fragilities of the reconstruction. The resulting diagnosis does not determine what should be pursued. It provides the structured practical object within which ends and evaluative standards can be specified with greater discipline. Section 285 therefore turns from diagnosis to *Goal and Criterion Specification*, examining how practical orientations become explicit goals, multiple criteria, thresholds, trade-offs, and revisable evaluative structures.

11.3 Situated Formation of Practical Orientations and Criteria

The role of this section is to specify how application-dominant praxis can acquire sufficient evaluative orientation for decision without presuming that goals, criteria, or

thresholds possess a universal form. Its objective is to treat practical orientations and evaluative criteria as historically situated and relationally conditioned objects whose content, authority, degree of explicitness, and mode of comparison can differ across practical fields. The discussion proceeds through historical-relational formation, normative provenance, plural orientations, situated criteria, local threshold construction, partial comparability, feasibility and protection conditions, and revision of the evaluative frame. The method is meta-methodological: it identifies dimensions that a practical inquiry may need to make explicit while leaving their substantive specification to the history, relations, institutions, affected positions, and normative commitments of the particular field.

Application-dominant praxis can begin with many kinds of orientation. A statutory mandate, emergency obligation, inherited institutional commitment, affected-subject claim, collective aspiration, protective principle, repair obligation, open-ended search for improvement, or attempt to preserve future possibility can each organize action. Some contexts support explicit goals and measurable criteria. Others contain contested orientations whose content is still being negotiated. Still others require exploratory action before a stable goal can be formulated. A meta-framework should therefore provide an architecture for making evaluative commitments traceable without converting one historically specific decision grammar into a universal procedure.

Definition 11.60 (Situated practical orientation). A *situated practical orientation* is a historically and relationally located direction, commitment, protection, obligation, aspiration, or valued condition that helps organize practical judgment within a specified field and whose standing depends on identifiable sources, affected positions, institutions, histories, and conditions of revision.

A goal is one possible articulation of a situated practical orientation. A criterion is one possible representation through which an orientation becomes assessable. A threshold is one possible boundary or trigger. Their methodological status therefore depends on the practical setting. The section uses these familiar objects while treating them as local constructions within a broader evaluative frame.

Definition 11.61 (Evaluative frame). An *evaluative frame* is the revisable configuration of practical orientations, criteria, protected conditions, comparison rules, temporal horizons, affected positions, authority relations, and uncertainty assumptions through which actions or consequences are interpreted for a particular practical purpose.

Table 11.3 summarizes the principal dimensions of this meta-level architecture. The rows are an analytical repertoire. A practical field can instantiate only the dimensions that are materially relevant, and the form taken by each dimension can change through the history of the intervention.

The architecture in Table 11.3 shifts the methodological emphasis from fixing a universal list of goals to documenting how practical orientation is constituted and revised. A numerical target, a qualitative protection, an institutional duty, a procedural requirement, and an open-ended commitment to preserve future options can all occupy legitimate positions within the framework when their standing is made explicit.

Table 11.3: Meta-level dimensions for the situated formation of practical orientations and criteria.

Dimension	Analytical object	Local question	Typical reopening condition
Historical formation	Origin and trajectory of practical orientation	Through which events and relations did the orientation acquire practical standing?	Changed field, newly recovered history, altered mandate
Normative provenance	Sources of value, obligation, authority, and protection	Whose commitments are represented, with what standing and contestability?	New affected position, conflict of authority, revised obligation
Plural orientation	Coexisting or layered practical directions	Which orientations reinforce, sequence, constrain, or remain in tension with others?	Newly visible conflict or changed temporal priority
Situated criteria	Representations used for assessment	Which features of the practical object are made assessable, and what remains outside the representation?	Proxy failure, scale mismatch, changed object
Thresholds and triggers	Local boundaries for action or review	Under which conditions is a threshold meaningful and authorized?	Changed baseline, regime shift, measurement drift
Partial comparability	Relations among heterogeneous values	Which comparisons are warranted without forcing complete commensuration?	Emergent value form, contested conversion, changed affected position
Feasibility and protection	Capacity, authority, rights, obligations, safety, material limits	Which practical directions remain reachable and admissible under current conditions?	Capacity change, legal change, new risk or protection claim
Frame revision	Evaluative architecture through time	Which events require reinterpretation, reauthorization, or reconstitution of the frame?	New evidence, performative change, failure, critical transition

11.3.1 Historical and Relational Formation of Practical Orientation

Practical orientation emerges within a history. Its content can depend on prior commitments, institutional trajectories, social expectations, accumulated harms, established capacities, legal arrangements, ecological conditions, or earlier interventions. A goal formulated at one historical moment can therefore lose relevance, acquire new meaning, or conflict with obligations that were previously weakly visible. The methodological task is to recover enough of this formation process that the orientation does not appear as an exogenous scalar attached to an otherwise complete decision problem.

A practical field can also contain several relational positions from which different orientations become intelligible. An implementing institution can emphasize continuity; an affected group can emphasize repair; a regulator can emphasize protection; a local practitioner can emphasize workable coordination; a future-facing planning process can emphasize option preservation. These orientations need not be reduced immediately to one objective. Their relational location is part of the practical information required for responsible comparison.

Definition 11.62 (Orientation-formation record). *An orientation-formation record identifies the events, relations, affected positions, institutional sources, normative commitments, temporal horizons, and uncertainties through which a practical orientation acquired its current form and standing.*

The record can be compact. Its purpose is traceability rather than exhaustive genealogy. Where the orientation is routine and uncontested, a statutory or organizational source can be sufficient. Where the orientation is disputed or historically burdened, deeper reconstruction can be required. The appropriate depth therefore depends on practical consequence and contestation.

The same framework accommodates emergent orientation. Some interventions begin with a broad direction such as exploration, stabilization, protection, learning, or restoration of practical capacity. More specific goals can be generated through diagnosis, participation, experimentation, or changed circumstances. A meta-methodology should preserve this possibility because premature specificity can close useful paths before the field is sufficiently understood.

11.3.2 Normative Provenance and Standing

A practical orientation carries normative provenance. The provenance concerns the sources through which a value, obligation, protection, or aspiration becomes relevant to action. These sources can include law, institutional mandate, prior agreement, affected-subject testimony, professional responsibility, ethical commitment, public deliberation, historical repair, or another locally justified basis.

Normative provenance and practical authority can diverge. A formally authorized institution can possess decision power while affected subjects possess distinctive knowledge of consequence. An expert body can possess technical competence while lacking authority to determine distributive priorities. A legal rule can impose a protection while leaving implementation details open. Methodological clarity therefore benefits from recording several forms of standing rather than compressing them into one variable.

Definition 11.63 (Normative-standing profile). *A normative-standing profile records the sources, scopes, affected positions, authority relations, contest routes, and revision conditions associated with the practical commitments used in a decision process.*

The profile can reveal that a disagreement concerns different kinds of standing. One actor can dispute the empirical means to an agreed end; another can dispute who has authority to define the end; a third can dispute whether the proposed category recognizes the affected relation at all. These disagreements call for different responses. Additional data can help the first, while participation, legal interpretation, institutional redesign, or ethical deliberation can be required for the others.

11.3.3 Plural and Layered Practical Orientations

Practical fields often contain several orientations that operate at different layers. Some concern immediate protection, others capability formation, institutional continuity, distributive consequences, procedural legitimacy, long-horizon resilience, or preservation of future options. Their relations can be reinforcing, sequential, conditionally conflicting, or only partially comparable.

A layered representation can be preferable to a single aggregated objective. Protective conditions can define a boundary within which exploratory learning occurs. A long-horizon orientation can constrain short-horizon optimization. A procedural commitment can govern how substantive goals are revised. A repair obligation can coexist with a generative orientation toward new capacities. The architecture therefore permits hierarchy, partial ordering, conditional precedence, and unresolved plurality where those structures better fit the field.

Definition 11.64 (Orientation architecture). An *orientation architecture* is a representation of the relations among coexisting practical orientations, including reinforcement, precedence, conditional dependence, protected status, tension, partial comparability, and conditions under which their relations can change.

An orientation architecture can remain qualitative. Formal multi-objective or partial-order representations become useful only when their semantics are justified. The broader methodological requirement is to avoid turning unresolved plurality into a fictitious common scale merely because a later decision method expects scalar input.

11.3.4 Criteria as Situated Representations

Criteria translate selected aspects of an evaluative frame into objects that can support practical judgment. Their role resembles other representations in GRE: they make some features visible and actionable while compressing others. A criterion can be quantitative, categorical, relational, historical, procedural, legal, interpretive, or mixed.

A criterion therefore requires an identifiable relation to the practical orientation it is intended to represent. Access can be represented through travel time, affordability, legal eligibility, linguistic intelligibility, practical usability, network reach, or combinations of these. Each choice constructs a different object of assessment. The criterion gains methodological force when the link between representation and orientation is explicit enough to examine whether the representation remains adequate.

Definition 11.65 (Situated evaluation criterion). A *situated evaluation criterion* is a contextually justified representation used to assess an action, history, relation, process, or consequence relative to one or more practical orientations within a specified scope and temporal horizon.

Criteria can also be distributed across methods. Statistical indicators can represent some features, historical reconstruction can represent others, and affected-subject interpretation can identify consequences that are poorly captured by administrative data. Methodological pluralism therefore extends to evaluation itself. A practical design can use several criteria with different epistemic forms while preserving their distinct evidential bases.

Criterion-object fit should be reconsidered when the practical object changes.

An indicator suitable during stable implementation can become misleading after a classification change, institutional reorganization, technological transition, or intervention-induced adaptation. Revision of the criterion can then be part of revision of the practical frame rather than a minor measurement adjustment.

11.3.5 Thresholds and Trigger Conditions

Thresholds can be useful where the practical field supports a defensible boundary or trigger. Examples include legal eligibility, safety limits, escalation conditions, resource minima, review dates, stopping rules, or model-specific transition indicators. Their role is local. A threshold acquires meaning through the process that defines the represented quantity, the consequences attached to crossing the boundary, and the authority through which the trigger becomes actionable.

A threshold can therefore be descriptive, normative, institutional, or operational. These functions should remain distinguishable. A statistically unusual value does not automatically constitute a normative violation. A legal threshold can bind action even when the underlying empirical quantity changes smoothly. A protective threshold can be intentionally conservative. An adaptive trigger can be revised as learning changes the model.

Definition 11.66 (Threshold provenance profile). A *threshold provenance profile* records the represented quantity or condition, source of the boundary, practical function, affected positions, uncertainty, authority, and conditions under which the threshold should be reconsidered.

Thresholds can become especially fragile when the baseline or regime changes. A trigger calibrated under one historical configuration can lose meaning after the observation system, population, institution, or dynamical regime changes. Sections 11.11 and 11.26 develop these transition and temporal-transfer issues at the level of decision architecture.

11.3.6 Partial Comparability and Heterogeneous Value

Practical comparison does not require complete commensurability. Some evaluative dimensions can be ordered locally, some can be converted under explicit conventions, and others can remain only partially comparable. The framework therefore permits scalarization, vector comparison, lexicographic protection, partial ordering, deliberative judgment, or preservation of incomparability where each is justified.

This distinction matters because conversion is itself a practical act. Assigning a monetary equivalent, score, rank, or common utility can create a powerful coordination device while also suppressing dimensions that the conversion does not preserve. GRE later treats heterogeneous value conversion as a substantive economic problem. At the present meta-methodological level, the requirement is narrower: the decision architecture should record when comparison depends on a conversion rule and what remainder that rule leaves outside the common scale.

Definition 11.67 (Comparability profile). A *comparability profile* records which evaluative dimensions can be compared directly, which require an explicit conversion or aggregation rule, which admit only partial ordering, and which remain deliberately uncollapsed within the current practical frame.

Partial comparability can support action. A project can identify dominated alternatives, protected conditions, acceptable regions, or priority relations without producing one global ranking. This possibility is important for a meta-framework because many historically situated decisions contain legitimate value heterogeneity that should remain visible after method selection.

11.3.7 Feasibility, Authority, Protection, and Constraint

Practical orientations operate within fields of capacity and constraint. A desired transformation can be materially infeasible, institutionally unauthorized, legally restricted, ethically inadmissible under the adopted commitments, or dependent on capacities that do not yet exist. These conditions have different meanings and should remain analytically distinct.

Feasibility concerns whether an action or trajectory is reachable under represented conditions. Authority concerns whether relevant actors possess standing to authorize or implement it. Protection concerns conditions whose preservation constrains action because of rights, safety, responsibility, ecological boundaries, or other justified commitments. Capacity concerns whether the field contains the resources, relations, knowledge, coordination, and institutional ability required for the contemplated transformation.

Definition 11.68 (Practical admissibility profile). A *practical admissibility profile* records the material feasibility, institutional authority, protective conditions, required capacities, and salient uncertainties that condition whether a contemplated practical direction can be pursued within the current field.

The profile can change through intervention. Capability building can make a previously latent action feasible. Legal reform can change authority. A new affected position can reveal a protection not previously represented. Resource depletion can foreclose a pathway. This reinforces the need to treat goal and criterion architecture as historically evolving rather than as fixed input to the rest of the chapter.

11.3.8 Revision and Reconstitution of the Evaluative Frame

Evaluative revision can take several forms. A criterion can be recalibrated while the underlying orientation remains stable. A practical orientation can be reinterpreted after new historical knowledge. A protected condition can acquire greater standing after an affected position becomes visible. A goal can be abandoned after its generative consequences become unacceptable. An entire evaluative frame can be reconstituted when the practical field changes sufficiently that the previous grammar of assessment no longer fits.

Definition 11.69 (Evaluative-frame revision). An *evaluative-frame revision* is a documented change in the practical orientations, criteria, comparison rules, protected conditions, temporal horizons, authority relations, or affected positions through which a decision or intervention is assessed.

Revision requires provenance because changing criteria can otherwise obscure failure or weaken accountability. A revised frame should identify the event or argument motivating the change, the positions involved, the scope of the revision, its relation to earlier commitments, and whether previous decisions require reinterpretation. This does not require a single formal protocol. The documentation depth should

reflect the consequence of the change.

The distinction between revision and strategic drift is practical rather than purely semantic. Revision is methodologically defensible when its reasons remain available for scrutiny and when materially affected positions can contest the change through appropriate channels. Strategic drift occurs when criteria are adjusted mainly to preserve a preferred conclusion without adequate disclosure or justification. Traceability therefore becomes part of evaluative integrity.

Proposition 11.70 (Situating evaluative formation). *Within application-dominant praxis, goals, criteria, thresholds, and comparison rules are methodologically stronger when their historical formation, relational location, normative provenance, practical scope, and revision conditions remain explicit enough to support the decision being made. Their useful specification need not take the same form across different histories or relational fields.*

Proposition 11.70 defines the meta-level role of this section. The framework does not require every practical field to produce a fully specified objective function before action. It requires the evaluative commitments that materially organize action to remain proportionately visible, situated, and revisable. Section 11.4 turns to the corresponding epistemic problem: how an inherited and evolving state of knowledge can warrant practical commitment without reproducing the evidence epistemology and evidence-generation methods already developed in Parts II and III.

11.4 Epistemic Conditions of Practical Commitment

The role of this section is to define the interface between knowledge and practical commitment within application-dominant praxis. Its objective is deliberately narrower than a general epistemology of evidence. Chapter 5 developed evidential access, representation, uncertainty, performativity, machine-mediated knowledge, revisability, and epistemic justice, while Part III developed research designs through which evidence can be generated, interpreted, triangulated, and validated. The present section begins after some epistemic state has already been produced and asks how that state can enter consequential action. The discussion proceeds through inherited epistemic states, epistemic events and uptake, claim-to-commitment traceability, commitment-relative sufficiency, evidential burden, conflict and protected uncertainty, temporal validity, performative recursion, model plurality, and re-opening conditions. The method is meta-methodological: it specifies conditions for responsible translation from warranted claims to practical commitment while preserving the plurality of evidential and research methods developed earlier in the book.

This distinction is important for the architecture of Chapter 11. Evidence collection is not treated here as a subordinate stage of decision engineering. A field can be investigated through statistical, historical, ethnographic, institutional, participatory, legal, computational, or mixed methods, and each can produce different forms of warranted claim. Application-dominant praxis receives those claims together with their provenance, uncertainty, scope, and disagreements. The practical question is then whether a contemplated commitment is adequately supported given its depth, reversibility, temporal horizon, affected positions, and possible consequences.

Definition 11.71 (Inherited epistemic state). *An inherited epistemic state is the*

versioned configuration of warranted claims, observations, interpretations, uncertainties, disagreements, model assumptions, source provenance, and recognized absences that a practical process receives from prior or ongoing inquiry at a specified historical moment.

The inherited epistemic state is not assumed to be complete or internally homogeneous. It can contain quantitative estimates alongside historical interpretations, legal findings, local knowledge, contested classifications, model ensembles, and acknowledged unknowns. Its function is to preserve what is currently known and how it is known well enough for the contemplated practical decision.

Table 11.4 summarizes the evidence-to-commitment interface developed in this section. The table should be read as a set of relations to examine rather than as a universal sequence.

The interface in Table 11.4 leaves the evidential methods themselves open. A practical process can inherit evidence from randomized experiments, observational studies, archival reconstruction, expert interpretation, participatory inquiry, legal analysis, simulation, or other methods without requiring their reduction to one evidential score. The decision architecture instead tracks the relation between the epistemic state and the commitment being contemplated.

11.4.1 Inherited Epistemic State

An application-dominant process rarely begins from epistemic zero. It inherits classifications, records, models, narratives, institutional memory, prior evaluations, practical experience, and unresolved disputes. These materials have different histories and evidential statuses. A decision process should therefore preserve their source and scope before attempting synthesis.

The inherited state can be represented through a dossier, evidence map, claim graph, model ensemble, historical narrative, legal record, or another form suited to the practical problem. Formal representation is optional. What matters is that consequential claims can be traced to the inquiry through which they acquired standing and that recognized gaps remain visible.

The relevant epistemic state is commitment-specific. A decision about a small reversible trial can require less settled knowledge than a long-duration institutional redesign. A decision about emergency protection can rely on a different combination of evidence and precaution than a decision about durable allocation. The same evidence base can therefore be adequate for one practical commitment and inadequate for another.

11.4.2 Epistemic Events and Practical Uptake

Knowledge enters practical history through events. Observation, interpretation, classification, recognition, publication, communication, recommendation, legal determination, expert judgment, or institutional acceptance can each change what actors know and can also change what actors do. The distinction between epistemic content and practical uptake is therefore central to application-dominant praxis.

Definition 11.72 (Epistemic event). An *epistemic event* is a historically located occurrence through which information, observation, classification, interpretation, recog-

Table 11.4: Meta-level interface between epistemic states and practical commitment.

Interface	Primary object	Practical question	Possible response
Epistemic inheritance	Claims, interpretations, uncertainty, provenance	Which parts of the current knowledge state bear on the contemplated commitment?	Scope restriction, synthesis, additional inquiry
Epistemic uptake	Recognition, interpretation, communication, institutional admission	Does an epistemic occurrence remain informational or alter the practical field through uptake?	Trace uptake, separate readout from transformation
Claim-to-commitment link	Inferential and normative chain	Through which judgments does a warranted claim support this action?	Explicit reasoning, preserved assumptions, contestability
Commitment-relative sufficiency	Evidence relative to consequence and reversibility	Is the epistemic state adequate for this depth and duration of commitment?	Proceed, stage, narrow, monitor, defer, return to research
Protected uncertainty	Conflict, missingness, unknown structure	Which uncertainties should remain visible inside the decision?	Branching histories, safeguards, bounded authorization
Temporal validity	Historical conditions of evidence	Does the evidential basis remain applicable after field or regime change?	Revalidation, transport qualification, reopening
Performative recursion	Evidence whose uptake changes later conditions	Does using the evidence modify the field from which later evidence will arise?	Versioned monitoring, causal separation, model revision
Model plurality	Competing representations and inferential structures	Which practical conclusions depend on one representation?	Robustness analysis, parallel models, conditional decisions
Reopening	New evidence, changed field, failed assumptions	Which epistemic changes require reconsideration of commitment?	Re-diagnosis, reauthorization, action-space revision

dition, communication, or model-mediated inference acquires a specified epistemic status within a practical field and can thereby affect later judgment, representation, or action.

An epistemic event can remain informational. A privately inspected monitoring report can revise an analyst’s model without materially changing the wider field. The same report can become performative when publication changes expectations, eligibility, coordination, resource allocation, or institutional response. The practical record should distinguish these roles because later evidence can otherwise be misinterpreted as if it arose under unchanged conditions.

Definition 11.73 (Epistemic-uptake trace). An *epistemic-uptake trace* records the source, content, interpretive pathway, institutional or practical uptake, affected positions, and materially relevant consequences of an epistemic event.

The trace need not imply a formal operator. Section 11.12 develops operator, field, network, dynamical, and other representations for applications in which formalizing the transformation is useful. The present section requires only that the distinction between learning about the field and changing the field through epistemic uptake remain conceptually available.

11.4.3 Claim-to-Commitment Traceability

A warranted empirical or interpretive claim does not by itself specify a practical commitment. Action requires additional judgments concerning practical orientation, affected positions, admissible risk, authority, timing, scale, reversibility, and responsibility. The claim-to-commitment link should therefore remain traceable enough that these additional judgments do not disappear behind the authority of evidence.

Definition 11.74 (Claim-to-commitment chain). A *claim-to-commitment chain* is the documented sequence of epistemic, interpretive, normative, institutional, and practical judgments through which one or more warranted claims are used to support, qualify, stage, or reject a contemplated commitment.

The chain can include explicit assumptions. A forecast can support capacity preparation only under an assumption about transportability and a judgment about acceptable shortage risk. A causal estimate can support intervention only under assumptions about mechanism stability and a decision concerning distributive consequences. A historical analogy can support caution only through a stated interpretation of relevant similarity. Traceability makes these transitions available for criticism.

This architecture also preserves the difference between evidential disagreement and normative disagreement. More data can sometimes reduce the former. The latter can persist even when the parties accept the same evidence. A practical method that treats every disagreement as an information deficit can therefore misdiagnose the decision problem.

11.4.4 Commitment-Relative Epistemic Sufficiency

Epistemic sufficiency is relative to the commitment being considered. The framework does not assume one confidence threshold that licenses action across domains. It instead relates the required evidential support to practical consequence, reversibility, scale, duration, distribution of risk, capacity for monitoring, and availability of repair.

Definition 11.75 (Commitment-relative epistemic sufficiency). An epistemic state has *commitment-relative sufficiency* when its warranted claims, recognized uncertainties, provenance, and contestability are adequate for the depth and consequence of a specified practical commitment under the safeguards and revision capacities available in the field.

Sufficiency therefore need not mean certainty. A bounded pilot can be justified under substantial uncertainty when exposure is limited, monitoring is informative, rollback is credible, and affected positions are protected. The same evidence state can be inadequate for a deep and difficult-to-reverse intervention whose consequences

are concentrated or whose failure cannot be repaired.

Sufficiency can also be conditional. Authorization can be granted for one stage while later stages remain contingent on additional evidence. A commitment can be restricted to selected populations or sites while transportability is investigated. The practical architecture can therefore convert epistemic uncertainty into staged authorization rather than forcing an all-or-nothing decision.

11.4.5 Commitment Depth and Evidential Burden

The relationship between epistemic burden and commitment depth is one of the central interfaces between research and action. Deeper interventions can alter institutions, subject positions, capacities, classifications, dependencies, or future action spaces. Longer commitments can expose later populations to assumptions made under earlier conditions. Hard-to-reverse commitments can make learning after implementation less capable of correcting error.

Proposition 11.76 (Escalating epistemic burden). *Where practical commitments become deeper, longer, more difficult to reverse, more distributively concentrated, or more dependent on uncertain mechanisms, the decision architecture should generally require correspondingly stronger justification, traceability, protection, monitoring, or staged authorization, subject to the urgency and opportunity costs of delay.*

Proposition 11.76 is deliberately conditional. Emergency action can make delay itself costly. Some harmful conditions persist precisely because institutions demand impossible certainty before intervention. The proposition therefore concerns proportionality of epistemic and protective architecture rather than a universal preference for caution.

The evidential burden can be distributed across several devices. Stronger prior evidence is one route. Greater reversibility, smaller scale, independent monitoring, explicit compensation, protected exit, and staged escalation can also reduce the practical consequences of epistemic error. Decision design can therefore respond to uncertainty by changing the commitment itself.

11.4.6 Conflict, Missingness, and Protected Uncertainty

Practical decisions often contain unresolved evidential conflict or missingness. Different models can disagree, administrative data can omit relevant relations, affected subjects can report consequences absent from aggregate indicators, and historical records can support competing interpretations. The meta-framework treats these conditions as part of the epistemic state rather than as defects that must always be erased before action.

Definition 11.77 (Protected uncertainty). *A protected uncertainty is a materially relevant uncertainty, disagreement, or recognized absence that remains explicitly represented in a practical decision because available inquiry has not warranted its resolution and because suppressing it could distort commitment, monitoring, or responsibility.*

Protected uncertainty can influence action in several ways. It can motivate branching scenarios, safeguards, staged commitment, wider participation, additional inquiry, or explicit contingency plans. It can also remain as an interpretive

remainder when a decision must proceed under time pressure. The key requirement is that the unresolved status not be converted silently into a precise input merely to satisfy a formal model.

Missingness can itself be relationally generated. A group can be absent because the administrative system does not recognize it; an informal relation can be weakly recorded because institutions lack incentives to document it; a harm can remain invisible because the observation scale is too coarse. Research methodology in Part III addresses how such missingness can be investigated. Chapter 11 asks what practical burden remains while the missingness is unresolved.

11.4.7 Temporal Validity and Transport Conditions

Evidence has a historical location. A claim can be well supported for a population, institution, measurement regime, relation structure, or dynamical regime at one period and require revalidation after those conditions change. Practical commitment should therefore record the temporal and relational conditions under which evidence is being transported.

Definition 11.78 (Evidence-transport profile). An *evidence-transport profile* records the historical period, field conditions, population or relational structure, observation regime, institutional context, and mechanism assumptions under which evidence was generated, together with the similarities and differences relevant to its proposed practical use.

Transport can be straightforward when relevant conditions remain stable enough for the practical purpose. It can become difficult after institutional reform, technological change, population change, crisis, changing classification, prior intervention, or a possible regime transition. Section 11.11 develops the special case in which the stability of local response itself becomes uncertain near a qualitative transition.

Temporal validity also matters during long interventions. Evidence supporting initiation can age while implementation changes the field. A monitoring architecture should therefore identify which assumptions require periodic re-examination and which evidence remains historically anchored to an earlier configuration.

11.4.8 Performative Uptake and Recursive Evidence

Using evidence can change the world from which subsequent evidence is generated. A classification can change eligibility, a forecast can alter expectations, a public indicator can redirect organizational effort, and a recommendation can coordinate behavior. These effects create a recursive relation among evidence, decision, and later observation.

The practical architecture should therefore distinguish at least three moments: the epistemic claim before uptake, the process through which the claim becomes practically consequential, and the later evidence generated after the field has responded. The later evidence can still be informative, but its interpretation should account for the intervention or representational event that helped produce it.

Performative uptake can also change the relative support assigned to alternative histories. A forecast that triggers precaution can make the forecasted adverse history less likely. A public commitment can make a previously unlikely coordination his-

tory more accessible. Such reweighting is model-relative and need not be represented numerically. Where numerical history weights or transition kernels are useful, Section 11.12 provides the formal apparatus.

Proposition 11.79 (Recursive evidence use). *When the practical uptake of evidence materially changes the conditions that generate later evidence, evaluation should interpret subsequent observations as products of the changed history and preserve the uptake event within the causal and epistemic record.*

This proposition is central to monitoring and adaptive revision. A model can appear to lose predictive accuracy because the intervention succeeded in changing the process it predicted. It can also appear to perform well because institutional reliance on the model helped create the pattern it forecast. The epistemic record should permit these possibilities to be distinguished where they matter.

11.4.9 Model Plurality and Decision Dependence

Application-dominant praxis can inherit several reasonable models of the same field. They can differ in boundary, variables, historical reconstruction, mechanism, scale, temporal resolution, uncertainty structure, or value-relevant outputs. A decision architecture should therefore ask which practical conclusions remain stable across models and which depend on one representation.

Model plurality need not be resolved by selecting one winner. Competing models can define a robustness family, support conditional decisions, motivate differentiated monitoring, or identify assumptions whose empirical investigation has unusually high practical value. Historical and interpretive representations can also participate in this plurality where they provide access to structures absent from formal models.

Proposition 11.80 (Plural updating in evolving decision spaces). *Where several defensible models support materially different practical conclusions, the decision process should preserve model dependence explicitly and connect later evidence to model comparison, action-space revision, or staged commitment in a form proportionate to the consequences of error.*

Model dependence becomes particularly important when the field can change because of the decision. An intervention can invalidate assumptions shared by several models or make a previously weak model more relevant. Model plurality is therefore historical rather than a one-time pre-decision exercise.

11.4.10 Epistemic Reopening and Research Recoupling

Practical commitment does not close inquiry. An intervention can encounter evidence that contradicts its mechanism, reveal an affected position omitted from the original frame, cross into a different dynamical regime, generate a new action, or expose a representational failure. These events can require a return to research-dominant praxis before further commitment.

Definition 11.81 (Epistemic reopening condition). *An epistemic reopening condition is an event, discrepancy, uncertainty change, performative effect, model conflict, or field transformation that makes one or more assumptions supporting a practical commitment insufficiently warranted for continued use at the current depth of action.*

Reopening can occur at different depths. A local parameter can be recalibrated. A criterion can be revised. The diagnostic boundary can expand. A causal mechanism can be reconsidered. A model family can be retired. A deeper change can return the project to historical, participatory, empirical, or theoretical inquiry before the action space is reconstructed.

The possibility of return is a constitutive feature of the architecture. Research-dominant and application-dominant praxis remain distinct in function, yet their histories can interleave. Application produces new evidence; research revises knowledge; revised knowledge changes practical commitment; practical commitment changes the field again. Chapter 11 therefore treats the evidence-to-action interface as recursive and historically open.

The next section develops decision analysis within this open epistemic architecture. The decision problem is not a fixed mapping from evidence to a pre-given action menu. It concerns historically situated subjects, evolving action spaces, multiple histories, revisable evaluative frames, and commitments whose evidential adequacy depends on what the commitment can generate.

11.5 Practical and Epistemic Situation Mapping

The role of this section is to provide a provisional map of the practical and epistemic situations within which application-dominant praxis may have to form commitments. Its objective is diagnostic rather than classificatory in a strong ontological sense: the section identifies dimensions that can change the adequacy of decision methods, the burden of evidence, the relevance of participation, the interpretation of uncertainty, and the design of revision or exit. The discussion proceeds through epistemic accessibility, probabilistic characterizability, model agreement, historical transport, dynamical condition, critical-transition uncertainty, stakes and reversibility, reflexivity, relational heterogeneity, power and responsibility, compound situation profiles, and revision of the map itself. The method is comparative and meta-methodological. The dimensions are offered as an open analytical repertoire rather than as an exhaustive taxonomy of practical reality.

A decision situation can be difficult for several different reasons. Information may be sparse even when the underlying process is comparatively stable. Probabilities may be estimable while consequences are difficult to reverse. Models may disagree because they represent different mechanisms rather than because one is simply erroneous. A field may be well observed and nevertheless evolve so rapidly that a stable decision representation expires before action is completed. A decision can also become performative when its announcement, classification, forecast, or implementation changes the relations from which later evidence is generated. Treating these conditions as one undifferentiated category of “uncertainty” can conceal the methodological differences among them.

The present map therefore uses dimensions rather than mutually exclusive classes. A practical situation can be high-stakes and well observed, deeply uncertain and readily reversible, turbulent and low-stakes, near a possible critical transition while remaining institutionally controllable, or strongly performative under otherwise stable conditions. Several dimensions can change simultaneously. Their practical relevance also depends on the action under consideration: an uncertainty that is negligible for

Table 11.5: Illustrative dimensions for practical and epistemic situation mapping.

Dimension	Illustrative range	Methodological significance
Epistemic accessibility	Directly observed; partially observed; weakly accessible; materially inaccessible	Affects evidential burden, inference, monitoring, and the role of situated or tacit knowledge
Probabilistic characterizability	Calibrated risk; unstable probabilities; ambiguous distributions; deep uncertainty	Affects the usefulness of expected-value, probabilistic, robust, and adaptive procedures
Model agreement	Convergent models; parameter disagreement; structural disagreement; poorly formed models	Affects reliance on single-model inference, model ensembles, stress tests, and qualitative comparison
Historical transport	Strongly comparable; partially transported; structurally shifted; weakly transportable	Affects whether past evidence and estimated mechanisms remain relevant to present commitment
Dynamical condition	Comparatively stable; rapidly changing; turbulent; transitional	Affects decision horizon, update frequency, representation stability, and the value of staged commitment
Critical-transition condition	No material indication; plausible proximity; model disagreement; active transition	Affects local extrapolation, sensitivity, hysteresis analysis, and transition-sensitive monitoring
Stakes and loss structure	Bounded consequence; high consequence; concentrated harm; catastrophic tail possibility	Affects review depth, redundancy, burden of justification, and responsibility design
Reversibility	Readily reversible; costly to reverse; path dependent; strongly irreversible	Affects experimentation, staging, option preservation, compensation, and exit architecture
Time pressure	Deliberative horizon; constrained horizon; rapidly closing window; emergency	Affects feasible inquiry, role of expertise, delegation, and the cost of delay
Reflexivity / performativity	Weak feedback; behaviorally responsive; institutionally performative; strongly self-altering	Affects deployment evaluation, model revalidation, and interpretation of post-decision evidence
Relational heterogeneity	Similar positions; differentiated positions; conflicting dependencies; strongly unequal consequences	Affects representation, participation, distributional analysis, and comparison across subjects
Power and responsibility	Dispersed; concentrated; delegated; distributed with possible responsibility gaps	Affects authorization, contestability, review, accountability, and persistence of decision authority

a reversible pilot can become decisive for a long-duration institutional commitment.

Definition 11.82 (Practical–epistemic situation profile). *A practical–epistemic situation profile* is a revisable representation of the conditions materially relevant to practical judgment, including the accessibility and transport of knowledge, the character of uncertainty, the dynamical and temporal condition of the field, the stakes and reversibility of commitment, the distribution of power and responsibility, and the degree to which observation or decision can alter the field itself.

Definition 11.82 does not imply that every project should measure every dimension. The profile is a prompt for discriminating among practical conditions that can require different methodological responses. Some dimensions can be quantified; others can be represented through qualitative ranges, historical reconstruction, institutional analysis, or explicit statements of unresolved uncertainty. A profile can also remain incomplete when the information required to characterize the situation is itself unavailable.

Table 11.5 summarizes an illustrative set of dimensions. The ranges in the table are descriptive anchors rather than calibrated scales. Their purpose is to make methodological assumptions visible before a decision process selects a particular model or procedure.

11.5.1 Epistemic Accessibility and Observability

Epistemic accessibility concerns the degree to which the practically relevant configuration can be observed, reconstructed, or inferred with the available epistemic infrastructure. Accessibility is broader than data volume. A field can generate extensive data while leaving important mechanisms, relations, histories, or affected positions weakly observed. Conversely, a small number of well-situated observations can sometimes disclose a practically decisive mechanism.

The distinction developed in Chapter 5 between manifestation and underlying relational structure remains important here. Observable indicators can provide access to selected manifestations while the practical object of interest depends on relations that are only indirectly represented. A monitoring system can observe service use while missing informal exclusion; a network measure can represent connections while omitting the meaning of dependence; an institutional record can document formal authority while practical influence remains distributed elsewhere.

Accessibility can therefore be represented through several channels: direct measurement, archival evidence, historical reconstruction, testimony, expert recognition, model-mediated inference, participatory mapping, and other forms of access appropriate to the field. The practical question is not whether one channel is intrinsically superior. It is which aspects of the decision object remain visible or invisible through the available combination.

A decision process can also alter observability. Classification can bring a previously informal relation into administrative view. Intervention can create new data streams while destroying older comparability. A powerful institution can make some actors easier to observe by requiring reporting while pushing other activity outside the formal system. Situation mapping should therefore distinguish present accessibility from the accessibility likely to exist after commitment.

11.5.2 Probabilistic Characterizability and Deep Uncertainty

Uncertainty admits several practical forms. Some decisions concern outcomes whose probability distributions can be estimated with sufficient stability for the intended use. Other decisions involve uncertain parameters within an accepted model family. Still others involve disagreement about models, causal structures, future conditions, relevant outcomes, or evaluative criteria. The methodological significance lies in the relation between the kind of uncertainty and the decision procedure being considered.

Research on decision making under deep uncertainty provides one neighboring family of approaches for cases in which actors cannot confidently specify a single probability model or long-horizon future and therefore examine robustness, adaptivity, pathways, and alternative futures (Marchau et al. 2019). GR can learn from such approaches without treating their categories as exhaustive or assuming that deep uncertainty is the only form of epistemic difficulty relevant to practical judgment.

The situation map should therefore record whether probability statements are empirically calibrated, structurally assumed, elicited from experts, generated through simulation, or used only as exploratory weights. It should also record which uncertainties remain outside the probabilistic representation. A numerical probability can be highly informative under one evidential regime and misleading when its precision

obscures unresolved model or historical uncertainty.

Deep uncertainty should likewise remain a scoped description. Some aspects of a practical problem can be deeply uncertain while others are well established. A decision can therefore combine probabilistic analysis for one component with scenario reasoning, historical interpretation, or qualitative safeguards for another. Methodological composition becomes more important as the uncertainty structure becomes heterogeneous.

11.5.3 Model Agreement and Representational Plurality

Model disagreement can arise from different parameter estimates, different structural assumptions, different boundaries, different temporal scales, different interpretations of the relevant subject, or different representational purposes. These forms of disagreement should not be collapsed into one model-error term. Two models can disagree because one represents short-horizon prediction while another represents an intervention mechanism; a historical reconstruction and a dynamical model can appear inconsistent because they preserve different kinds of information.

Situation mapping should therefore ask what each representation is intended to disclose and which practical claims depend on agreement among them. Convergence across models can increase confidence only when the models provide meaningfully distinct tests of the same claim. Agreement among several models built from the same assumptions, data, or boundary choices can provide less independent support than their number suggests.

Representational plurality can also remain unresolved. In some practical settings, the appropriate response to model disagreement is further research. In others, a decision window can close before disagreement is resolved. Robust comparison, sensitivity analysis, staged commitment, or explicit preservation of dissenting representations can then become relevant candidate responses. Their adequacy depends on stakes, reversibility, and the consequences of acting under the wrong model.

11.5.4 Temporal Transport and Historical Drift

Evidence is generated in time. Its practical relevance depends on whether the relations, institutions, classifications, technologies, populations, and mechanisms that supported an earlier inference remain sufficiently comparable to the present field. Temporal transport is therefore a dimension of the decision situation rather than a technical afterthought.

Historical drift can occur gradually or discontinuously. A measured relationship can weaken as behavior adapts. A legal reform can change the meaning of an administrative category. A new technology can alter the feasible action space. An earlier intervention can change who remains observable. A public model can alter expectations and thereby change the process that later data represent. These changes can matter even when standard predictive diagnostics show only modest statistical drift.

A situation profile should consequently identify the historical period from which decisive evidence is drawn, the transformations that occurred between evidence generation and current use, and the mechanisms assumed to transport. The confidence attached to a past result can then be separated from the confidence attached to its present applicability.

11.5.5 Dynamical Condition and Turbulent Practical Fields

The dynamical condition of a practical field concerns the stability of the relations required to maintain a useful decision representation over the relevant horizon. Some fields change slowly enough that a model, institutional map, and action set remain comparatively stable while deliberation proceeds. Other fields change rapidly through interacting actions, information, institutional responses, technological shifts, or external events.

The present framework uses *turbulent practical field* as a provisional methodological description rather than as an assertion that social or economic systems obey the mathematical dynamics of fluid turbulence.

Definition 11.83 (Turbulent practical field). A *turbulent practical field* is a practical configuration in which decision-relevant states, relations, constraints, actors, information structures, or feasible actions change sufficiently rapidly and interactively that a stable representation of the decision environment cannot be presumed to remain adequate over the horizon required for ordinary plan–execute–evaluate control.

Definition 11.83 is intentionally modest. It provides a vocabulary for situations in which the decision problem evolves while being addressed. The designation can be inappropriate when rapid change is superficial or when the relevant mechanism remains stable. It should therefore be treated as a revisable diagnosis rather than a categorical property of a field.

Naturalistic decision-making research offers an important neighboring perspective because it studies how experienced decision makers recognize and act within complex real-world conditions where time pressure, changing cues, and expertise can matter materially (Klein 2008). GR does not infer from this literature that intuition should replace analysis. The relevance is narrower: some decision situations place practical weight on situated recognition and tacit expertise that is difficult to reconstruct through exhaustive option comparison within the available time.

Turbulent conditions can make short decision horizons, frequent re-situation, distributed observation, provisional commitments, and rapid responsibility-preserving revision more salient. These are candidate responses rather than fixed rules. A rapidly changing field can also require decisive long-horizon commitment when delay itself produces irreversible loss. Situation mapping should therefore describe the dynamical condition before prescribing a response.

11.5.6 Criticality and Regime Uncertainty

Critical-transition uncertainty concerns the possibility that a system is near a qualitative change in response regime. Section 11.11 develops this condition in detail after robustness and adaptive decision-making have been introduced. The present subsection locates criticality within the wider situation map.

Possible proximity to a transition is analytically distinct from turbulence. A field can change rapidly without approaching a critical transition, and a system can approach a transition while its observable state appears comparatively stable. The distinction also matters for evidence. Ordinary local relationships can remain useful in a turbulent but regime-preserving condition, while apparently stable relationships can become fragile near a poorly observed transition.

Situation mapping should record the basis for any criticality claim, the models under which the claim arises, the indicators or mechanisms supporting it, the degree of disagreement among representations, and the consequences if the diagnosis is wrong. The absence of a reliable criticality indicator should remain visible rather than being replaced by a confident categorical label.

11.5.7 Stakes, Reversibility, and Time Pressure

Stakes, reversibility, and time pressure form distinct dimensions. A decision can be highly uncertain and low-stakes, comparatively predictable and catastrophic if wrong, highly consequential yet readily reversible, or moderately consequential but effectively irreversible because later correction is impossible. Time pressure adds another relation because further inquiry can itself consume an expiring opportunity.

High-stakes conditions therefore should not be treated as a single method class. The practical burden depends on who can be harmed, how harm is distributed, whether compensation or repair is possible, whether action creates long-duration dependency, and whether delay imposes its own costs. A safety-critical engineering decision, an emergency response, a reversible organizational pilot, and a constitutional institutional change can all be high-stakes in different ways.

Reversibility should likewise be represented relationally. An intervention can be reversible for the implementing institution while remaining irreversible for subjects who changed employment, residence, health, legal status, trust, or access in response to it. Section 11.25 later develops exit and rollback as historically situated processes rather than simple restoration.

Time pressure can increase the value of experienced judgment, pre-established protocols, delegation, and rapid sensing, while also increasing the risk of unreviewed authority or premature simplification. Situation mapping should therefore record both the cost of delay and the cost of insufficient deliberation.

11.5.8 Reflexivity and Performativity

A practical field is reflexive when representations, expectations, classifications, or announced decisions can influence the behavior of actors within the field. It is performative in the stronger practical sense used in this book when epistemic outputs enter institutional or relational processes and materially change the configuration that later generates evidence.

The degree of reflexivity matters for method selection. A quietly used diagnostic model can have limited behavioral effects, while a publicly announced forecast can coordinate expectations. A classification can alter eligibility. A ranking can change resource allocation. A monitoring indicator can become a target that reorganizes behavior around its measurement. These effects can make post-deployment data endogenous to the decision system.

Situation mapping should therefore record who can observe the decision process, how outputs circulate, which actors can respond strategically or institutionally, and whether the response changes the validity conditions of the original model. This dimension connects directly to the boundary conditions developed later in Section 11.26.

11.5.9 Relational Heterogeneity and Position

Practical situations can contain subjects whose exposure, capacity, dependence, knowledge, and standing differ substantially. An aggregate model can describe average outcomes while concealing that one group bears the transition cost, another controls the decision, and a third receives most of the generated capacity. Relational heterogeneity therefore affects both epistemic adequacy and normative interpretation.

A situation profile can identify differentiated positions without presuming a single morally correct aggregation. Relevant distinctions can include decision authority, exposure to loss, dependency, access to alternatives, ability to exit, informational access, capacity to contest, and the historical relations through which the present positions were formed. Which distinctions matter depends on the decision and should remain open to revision.

Heterogeneity can also occur within formally similar categories. Two organizations with the same legal status can occupy different network positions. Two households with similar income can differ in care obligations, time constraints, housing stability, or access to institutional support. Situation mapping should therefore avoid treating administrative categories as complete representations of practical position.

11.5.10 Power and Responsibility Configuration

Decision conditions differ according to who can authorize action, shape the representation of the problem, control information, allocate resources, impose costs, revise rules, and terminate the intervention. These capacities can be distributed across several institutions or concentrated in one position. Their practical significance depends on both formal authority and effective relational capacity.

Power concentration is not automatically evidence of methodological failure. Some conditions can require concentrated coordination or temporary emergency authority. The situation map should instead identify the source, scope, duration, review structure, and self-reinforcing mechanisms of decision power where these are material. An authority that expands because each intervention creates new dependency differs from an authority whose scope remains bounded by the task that justified it.

Responsibility configuration should be mapped separately from power. A participant can possess technical influence without formal authorization; an institution can hold formal responsibility while depending on a vendor or expert system it cannot meaningfully inspect; several actors can each satisfy their local duty while a system-level obligation remains unattended. These configurations prepare the responsibility-vacancy analysis in Section 11.26.

11.5.11 Compound Situation Profiles

Real decisions usually combine several dimensions. The practical significance of one dimension can change through its interaction with another. Deep uncertainty is more consequential when commitment is irreversible. Time pressure changes the value of additional evidence. Power concentration can become more problematic when uncertainty is high and contestability is weak. Performativity can make an otherwise well-calibrated prediction unstable after deployment.

Definition 11.84 (Compound situation profile). A *compound situation profile* is a situation representation in which several practical and epistemic dimensions are considered jointly because their interaction materially affects method selection, commitment depth, monitoring, responsibility, or revision.

A compound profile does not need to reduce the dimensions to one score. In many cases, the value of the profile lies precisely in preserving their distinct meanings. A decision can then be described, for example, as high-stakes, moderately observable, deeply uncertain with respect to long-horizon mechanisms, partially reversible, strongly performative, and institutionally concentrated. Such a description can guide methodological composition more transparently than a single label such as “complex” or “risky.”

Compound profiles can also change during intervention. Monitoring can improve observability; institutional reorganization can redistribute power; a pilot can reduce mechanism uncertainty; public controversy can increase performativity; a previously reversible decision can become locked in through investment or expectation. Situation mapping should therefore be versioned when the decision process extends through time.

11.5.12 Open Taxonomy and Revision

The dimensions developed in this section are examples drawn from the methodological problems already present in the book. They do not constitute a complete taxonomy of decision or epistemic situations. New technologies, institutional forms, forms of agency, environmental conditions, or research developments can make other dimensions practically important. A field can also require a distinction that has little relevance elsewhere.

Caution 11.85 (Open status of situation mapping). The practical–epistemic situation map is a revisable analytical aid. Its dimensions, boundaries, and descriptive ranges should be modified when they fail to represent materially relevant conditions of a practical field. The map should not be used as a closed ontology of decision situations or as an algorithm that determines method from classification alone.

Caution 11.85 preserves the meta-methodological status of the chapter. Situation mapping helps identify why a decision is difficult and what forms of inquiry or protection may deserve attention. It does not determine what should be valued, which method must be used, or which action is justified.

The next section develops a corresponding repertoire of situated considerations and candidate practical orientations. Those orientations remain defeasible and condition-sensitive. Their purpose is to make recurrent practical questions available for reflection without converting them into universal GR commandments.

11.6 Situated Considerations and Candidate Practical Orientations

The role of this section is to identify practical considerations that can become salient after a situation has been provisionally mapped, and to formulate a limited set of candidate orientations that may help organize judgment under specified condi-

tions. Its objective is neither to supply a universal ethics of Generative Relational praxis nor to convert recurrent concerns into fixed decision rules. The discussion proceeds through the status of candidate orientations, epistemic and dynamical considerations, relational and distributional consequences, power and responsibility, value articulation, relational viability and transformation, reversibility and option preservation, methodological composition, proportionality of commitment, defeasibility, and methodological emergence. The method is normative-analytic and meta-methodological. Each orientation is treated as a possible reason for attention whose relevance, interpretation, priority, and relation to competing considerations depend on the historical-relational field.

The distinction between a *consideration* and a *principle* is important. A consideration identifies something that can matter to practical judgment: reversibility, distribution of harm, historical transport of evidence, concentration of authority, or loss of future options. A candidate principle proposes a defeasible orientation for responding to such a consideration under some conditions. Neither status implies universal priority. An orientation can be useful in one situation and weak, infeasible, or counterproductive in another.

Definition 11.86 (Candidate practical orientation). A *candidate practical orientation* is a provisional and defeasible reason for structuring inquiry, decision, or intervention in a particular way when specified features of a practical situation make that orientation relevant. Its standing remains open to contextual qualification, conflict with other considerations, empirical revision, and normative contestation.

Definition 11.86 deliberately avoids treating the orientations below as axioms of GR. Some can acquire stronger force through law, professional duty, explicit institutional mandate, prior agreement, or a separately defended normative theory. That stronger force comes from the relevant source of obligation rather than from inclusion in this chapter.

Table 11.6 gives an illustrative map from situation characteristics to considerations and possible orientations. The table is not a decision algorithm. Multiple orientations can become relevant simultaneously, and some can conflict. The practical task is to make those conflicts explicit enough for situated judgment, deliberation, or further inquiry.

11.6.1 Status of Candidate Orientations

Candidate orientations occupy an intermediate methodological status. They are more specific than a list of possible consequences because they indicate a direction for practical design, yet they remain weaker than universal obligations. Their force arises from the situation, the normative sources recognized in that field, the evidence available, and the consequences of alternative commitments.

This status is useful for a meta-framework because practical reasoning often requires guidance before a complete normative theory has been settled. A project can reasonably ask whether to preserve reversibility, widen participation, distribute monitoring, or limit the automatic extension of temporary authority without pretending that one answer applies to every domain. The chapter can make those recurrent questions visible while keeping their resolution open.

Candidate orientations can also conflict. Preserving options can reduce decisiveness. Broad participation can consume scarce time. Central coordination can im-

Table 11.6: Illustrative practical considerations and defeasible candidate orientations.

Situation characteristic	Consideration	Possible orientation	Qualification
Deep or model uncertainty	Dependence of conclusions on contested futures or structures	Robust comparison, adaptive pathways, preserved learning capacity	Flexibility can be costly and may delay necessary commitment
High stakes	Consequences of error and unequal exposure	Greater review, redundancy, proportionate evidential burden	Urgency can limit feasible review; additional procedure can itself impose harm
Strong irreversibility	Path dependence and limited repair	Staged commitment, pilot action, option preservation where feasible	Some benefits require irreversible or large-scale commitment
Time pressure / turbulence	Rapidly changing cues and action space	Shorter review cycles, situated expertise, distributed sensing, rapid re-situation	Fast action can entrench error or authority if review disappears
Possible critical transition	Regime instability, amplification, hysteresis	Model plurality, transition-sensitive monitoring, staged action	Criticality diagnosis can itself be uncertain or model-dependent
Value plurality	Different affected positions and meanings	Co-articulation or co-creation of evaluative criteria where appropriate	Participation can be infeasible, unequal, strategic, or constrained by prior rights and duties
Strong power asymmetry	Dependency and self-reinforcing authority	Explicit review of power expansion, contestability, renewal or sunset conditions where suitable	Concentrated authority can sometimes be necessary for coordination or emergency response
Strong performativity	Decision output changes later evidence	Reflexive monitoring, deployment logging, model revalidation	Some performative effects are intended and beneficial
Distributed responsibility	Possible gaps among technical and institutional roles	Explicit responsibility architecture and identifiable duties	Shared responsibility need not be centralized in one actor
Relational fragility or lock-in	Persistence, dependence, exit, and future transformation	Examine viability, transformability, and conditions for safe dissolution	Persistence is not itself a good; some relations should end

prove response speed while increasing concentration of authority. Strong standardization can improve consistency while losing contextual meaning. A methodologically mature decision process should therefore preserve the conflict rather than defining one orientation as lexically prior by default.

Caution 11.87 (Defeasible status). The candidate orientations developed in this section are illustrative, defeasible, and incomplete. Inclusion in the present repertoire does not establish universal validity, priority, or applicability. Additional orientations can emerge from domain-specific practice, new forms of agency, institutional learning, or later theoretical development.

11.6.2 Epistemic Considerations

Practical judgment can begin by distinguishing what is observed, inferred, assumed, contested, inaccessible, and expected to change. This distinction supports an epistemic orientation toward traceability: consequential claims can be linked to their evidential sources, model assumptions, interpretive steps, and unresolved uncertainties at a depth proportionate to the decision.

Traceability does not imply that every form of knowledge must be converted into formal data. Historical interpretation, local knowledge, testimony, professional expertise, and tacit recognition can remain relevant epistemic forms. Their standing should be articulated through appropriate standards of credibility, provenance, corroboration, and scope rather than forced into a measurement regime that destroys

their meaning.

A second consideration concerns epistemic diversity. Where materially different methods disclose different aspects of the field, premature reduction to one representational language can remove useful disagreement. A formal model can reveal sensitivity, consistency, and consequences across large scenario spaces; an institutional history can explain how the modeled categories acquired their present meaning; participants can disclose unrepresented dependencies; experienced practitioners can recognize patterns that are difficult to operationalize quickly.

The corresponding candidate orientation can be stated modestly: where several epistemic modes carry materially relevant information, practical reasoning may benefit from preserving their distinct contributions long enough for reciprocal comparison and correction. This is compatible with strong reliance on one method when the local problem justifies it.

11.6.3 Dynamical and Temporal Considerations

The dynamical state of the field can affect the appropriate rhythm of decision. A comparatively stable setting can support longer model-validation and planning cycles. A turbulent field can require shorter cycles of observation, commitment, and reassessment. A possible critical transition can increase the relevance of regime-sensitive monitoring and the cost of treating local regularities as stable.

Time itself creates trade-offs. Waiting can improve evidence while allowing an opportunity to disappear. Acting early can preserve an option while producing lock-in. A reversible intervention can generate information while changing the field from which that information is drawn. The practical question therefore concerns the relation among learning time, action time, consequence time, and the temporal horizon over which responsibility persists.

One candidate orientation is staged commitment where uncertainty is material and the practical field permits meaningful stages. Staging can separate exploratory action from deeper institutional commitment and can create points at which evidence, goals, authority, or design are reconsidered. The orientation remains conditional because some transitions require coordinated scale, and some delay can increase rather than reduce harm.

11.6.4 Relational and Distributional Considerations

A practical decision generates and transforms relations as well as outcomes. It can create dependence, coordination, access, exclusion, recognition, obligation, trust, conflict, and new forms of institutional mediation. These relations can persist after the immediate output of the intervention has disappeared.

Distributional analysis should therefore extend beyond distribution of a scalar benefit or cost when the field requires it. Subjects can receive different capacities, different burdens of uncertainty, different possibilities of exit, and different exposure to later institutional decisions. A change that improves aggregate performance can still reorganize who must depend on whom, who can challenge a decision, and who acquires durable control over an infrastructure or classification system.

A candidate orientation follows: where relational consequences are material, eval-

uation may include the distribution of generated capacities, dependencies, obligations, and future options in addition to immediate outcomes. This orientation does not predetermine which distribution is just. It expands the object made available for normative and political evaluation.

11.6.5 Power and Responsibility Considerations

Practical interventions can create power by generating control over resources, classifications, information, access, coordination, standards, or future decision points. Temporary capacities can become self-reinforcing when the intervention makes later actors increasingly dependent on the institution that implemented it. Conversely, dispersing authority can make coordinated action impossible or leave responsibility without an effective bearer.

The meta-framework therefore does not adopt decentralization or power minimization as universal principles. A more limited candidate orientation is to examine the generation, persistence, scope, and review of decision power when the intervention materially changes them. Where authority expands beyond the conditions that initially justified it, review, renewed authorization, contestability, or sunset arrangements can become relevant possibilities.

Responsibility requires a related but distinct analysis. Delegation can be technically efficient while leaving unclear who must verify inputs, authorize deployment, investigate failure, repair harm, or preserve records. The candidate orientation is responsibility retention: consequential methodological delegation should be accompanied by an explicit account of the duties that remain attached to human and institutional positions. Section 11.26 develops responsibility vacancy as one boundary condition of formal decision systems.

11.6.6 Value Articulation and Co-Creation

Values can enter a practical process through law, institutional mandate, prior agreement, professional obligation, affected-subject claims, cultural interpretation, political authorization, or local deliberation. In some situations the relevant values are comparatively settled. In others, the intervention itself changes which values become visible or how different subjects interpret them.

“Value should be co-created” would therefore be too strong as a general GR principle. Co-creation can be especially relevant where values are plural, contested, under-articulated, or materially transformed by the intervention and where affected subjects possess knowledge or standing that the initial evaluative frame does not capture. It can be less relevant where a protected right already constrains the decision, where a narrow technical task has an authorized objective, or where an emergency leaves little time for extended deliberation.

A defeasible orientation can be stated more carefully: where practical value is materially plural, contested, or generated through the intervention process, the formation and revision of evaluative criteria may benefit from appropriate participation or co-articulation by differently situated subjects. The form of participation remains a separate design question and can range from consultation to delegated authority, co-design, representation, or later contestability.

This formulation also prevents co-creation from becoming a rhetorical substitute

for responsibility. Inviting participation does not automatically legitimate a process, eliminate asymmetry, or transfer institutional obligations to affected subjects. The participation architecture developed later in Section 11.14 remains necessary.

11.6.7 Relational Viability and Transformation

The phrase *relational sustainability* can be useful only if its meaning is specified. Persistence, viability, and normative desirability are different properties. A relation can persist because exit is costly or coercively blocked. A relation can be viable for one participant while depleting another's capacity. A normatively valued relation can be temporarily fragile. Practical judgment therefore should not treat persistence or sustainability as an unconditional good.

Definition 11.88 (Relational viability). *Relational viability* is the capacity of a specified relational configuration to continue performing or reproducing specified functions or capacities over a specified horizon under stated conditions. The concept is descriptive until the relevant functions, subjects, horizon, and normative standing of continuation have been specified.

Definition 11.88 keeps viability separate from approval. The practical question can concern preservation, transformation, managed dissolution, or replacement. In some cases an intervention should preserve a cooperative relation; in others it should reduce a coercive dependency or dismantle an institution whose persistence blocks other possibilities.

A candidate orientation is therefore broader than relational sustainability: when relations are materially changed by a decision, practical judgment may examine their persistence, viability, transformability, dissolution costs, and effects on the capacities of differently positioned subjects. Which of these properties should be promoted remains a situated normative question.

This orientation also helps with uncertainty. Under a turbulent or transitional condition, preserving the current configuration may be neither feasible nor desirable. The relevant concern can instead be preservation of selected capacities through transformation: access to basic resources, ability to coordinate, capacity to contest, practical alternatives, institutional memory, or other locally justified conditions. The choice among these capacities should remain explicit rather than hidden under the generic word "sustainability."

11.6.8 Reversibility, Option Preservation, and Learning

Reversibility can become salient when uncertainty is large, consequences are difficult to predict, or the intervention is expected to generate new information. Preserving the ability to revise can reduce the cost of model error and allow learning to alter later commitment. Adaptive planning traditions provide one neighboring methodological family in which strategies include monitoring and future adjustment under deep uncertainty (Marchau et al. 2019).

The corresponding orientation should remain conditional. Option preservation can impose real costs. Maintaining redundant infrastructure, delaying standardization, or preserving multiple pathways can consume resources that could otherwise improve present outcomes. Some achievements require commitment deep enough

to close alternatives. A framework that always maximized optionality would simply substitute one universal value for another.

A more modest formulation is that unnecessary destruction of future action possibilities deserves explicit consideration when uncertainty is material and future learning is expected to change the quality of judgment. The word *unnecessary* keeps the orientation tied to the practical field rather than elevating option preservation into an absolute principle.

Learning should likewise be understood broadly. A pilot can generate statistical evidence, but action can also generate institutional knowledge, reveal hidden relations, expose capacity constraints, or change the meaning of the problem. A learning-oriented intervention should therefore specify what kind of epistemic event would justify continuation, revision, escalation, or withdrawal.

11.6.9 Methodological Composition and Reciprocal Correction

Formal, quantitative, historical, interpretive, naturalistic, participatory, and experimental methods can contribute different forms of discipline to practical judgment. Formal and natural-scientific methods are especially valuable for making assumptions explicit, maintaining internal consistency, operationalizing variables and mechanisms, comparing counterfactuals, exploring large possibility spaces, and supporting empirical testing or calibration where the field permits it. Their limitations arise when representation omits materially relevant meanings, historical transformations, normative inputs, tacit expertise, institutional responses, or model-changing feedback.

Historical and interpretive approaches can preserve provenance, context, meaning, institutional memory, and transformations that resist compact formalization. Naturalistic approaches can disclose how experienced practitioners recognize patterns and act under complex field conditions (Klein 2008). Participatory methods can reveal affected positions, local knowledge, disagreement, and practical consequences that centralized models fail to represent. These modes also have limitations: interpretations can be difficult to compare operationally, expertise can be biased or overgeneralized, participation can be unequal or strategic, and local knowledge can transport poorly across contexts.

The resulting methodological pluralism should not be reduced to a ritual requirement that every project use every method. The candidate orientation is dialectical in a limited methodological sense: where materially different methods provide relevant access, they can be composed so that their disagreements, blind spots, and assumptions become objects of reciprocal correction rather than being forced prematurely into one representational language. Triangulation research likewise cautions that combining methods can produce convergence, inconsistency, or contradiction that still requires interpretation (Jick 1979; Mathison 1988).

Methodological composition is therefore a design problem. A formal model can identify a sensitive parameter that directs historical inquiry. Participant testimony can reveal a missing relation that requires the model boundary to change. A naturalistic expert can identify a pattern that simulation later tests. A failed prediction can motivate institutional reconstruction. The composition can evolve as the practical field generates new evidence and new methodological needs.

11.6.10 Proportionate Commitment and Review

The practical burden of evidence, deliberation, documentation, review, monitoring, and responsibility can reasonably depend on the depth of commitment. A short, reversible, low-stakes intervention does not necessarily require the same methodological architecture as a long-duration, high-stakes, institutionally deep, or difficult-to-reverse transformation.

A candidate orientation of proportionality can therefore connect situation mapping to method design. Greater stakes, irreversibility, uncertainty, relational heterogeneity, or concentration of power can increase the relevance of independent review, model plurality, participation, monitoring, explicit exit conditions, and responsibility documentation. The orientation remains defeasible because procedural burden can itself create harm, delay, exclusion, or administrative lock-in.

Proportionality should also apply to formalization. A small decision can be obscured by an elaborate model whose data requirements exceed its practical value. A high-stakes decision can be underserved by a simple heuristic merely because it is easy to implement. The appropriate resolution of method should be justified in relation to the consequences and uncertainty of the practical commitment.

11.6.11 Defeasibility and Conflict among Orientations

Candidate orientations can conflict in ways that cannot always be resolved by a common metric. Broad participation can conflict with emergency speed. Transparency can conflict with privacy or security. Reversibility can conflict with the investment required to generate long-term capacity. Distributed authority can conflict with responsibility clarity. Robustness across futures can conflict with optimization for a strongly supported near-term scenario.

The existence of conflict does not imply that the framework should remain silent. It implies that practical judgment should identify the conflict, the positions affected, the evidence supporting each concern, the normative sources that give the orientations standing, and the consequences of prioritizing one over another. Some conflicts can be resolved through design; others can remain genuinely political, legal, ethical, or institutional.

A GR meta-framework should therefore resist transforming candidate orientations into a hidden utility function. Their role is to widen and discipline practical attention. Where a legitimate authority or normative theory establishes a priority, the decision process can incorporate that priority explicitly. Where priority remains contested, the contest should remain visible in the decision record.

11.6.12 Methodological Emergence and Open Research Problems

The methods discussed in Chapter 11 are examples of methodological forms currently available to the research programme. They do not exhaust the methods that a future GR or GRE practice may require. New practical fields can generate new forms of evidence, agency, coordination, participation, computation, and intervention. Existing methods can also be transformed through their interaction with one another.

A particularly important open problem concerns methodological emergence: how

a practical field should generate, select, combine, and revise the methods through which it is known and governed. The present chapter offers situation mapping, candidate orientations, model plurality, historical interpretation, participatory method, intervention design, monitoring, and recursive revision as resources for this problem. It does not yet provide a complete theory of method composition under turbulence, deep uncertainty, high stakes, contested values, and changing power relations.

The same humility applies to the candidate orientations in this section. Value co-creation, relational viability, reversibility, option preservation, responsibility retention, power review, and epistemic plurality can each be useful under some conditions. None is asserted here as the invariant good of GR. Their relevance should be argued from the practical configuration and from whatever normative sources legitimately govern the decision.

Proposition 11.89 (Open methodological repertoire). *Application-dominant GR praxis can treat its methodological repertoire as historically revisable: situation categories, methods, evaluative considerations, and candidate practical orientations may be retained, modified, combined, or replaced when changes in evidence, agency, institutions, technology, relations, or normative understanding make alternative methodological forms more adequate to the practical field.*

Proposition 11.89 is a proposal about the status of the methodology rather than a claim that methodological change is always beneficial. Revision itself can introduce error, instability, or opportunistic manipulation. Methodological changes should therefore remain traceable and open to critical evaluation.

Sections 11.7 onward develop concrete families of decision and intervention method. They should be read in light of the two preceding sections: the methods form a repertoire whose relevance depends on the situation profile, and their practical use can be guided by candidate orientations without being mechanically determined by them.

11.7 Decision Analysis in Evolving Action Spaces

Section 11.4 established an epistemic architecture in which observation, interpretation, recognition, and evidence can update representations and can also become performatively coupled to transformations of an evolving relational field. Sections 11.5 and 11.6 then provided an open map of practical-epistemic situations and an illustrative repertoire of considerations and candidate orientations that can shape methodological composition. The role of the present section is to translate this meta-methodological preparation into decision analysis. Its objective is to develop a decision methodology that can compare and organize practical commitments while the relevant subjects, available actions, consequence structures, models, and future possibilities can themselves change through time. The discussion proceeds through ten movements: decision situations; historical-relational subjects; the status and provenance of actions; consequence and history structures; decision criteria; multi-criteria comparison; uncertainty and deep uncertainty; sequential and order-sensitive decision; collective decision; and revision of the action space. The method is formal-architectural and plural. It permits scalar optimization, probabilistic choice, qualitative comparison, partial ordering, historical interpretation, participatory judgment, and other decision procedures where their assumptions fit the practical

Table 11.7: Decision analysis in evolving action spaces

Component	Analytical object	Decision question	Characteristic methodological concern
Decision situation	Historically situated configuration, horizon, actors, and practical commitments	What exactly requires decision at this stage?	Boundary, timing, provenance, and changing field conditions
Historical-relational subjects	Subjects represented through histories, relations, capacities, roles, and internal structure	Who acts, who is affected, and how can the decision transform the subject?	Point-agent simplification, category change, relational dependence
Action-space status	Available, latent, and foreclosed actions with generative provenance	Which actions are reachable now, activatable later, or already lost?	Formal possibility versus effective reachability
History structure	Action-conditioned families of later histories	What trajectories can follow from each commitment?	Branching, path dependence, spillovers, future decision spaces
Decision criteria	Criteria applied to processes, histories, and consequences	Which dimensions matter for comparison?	Criterion fit, protected values, temporal and relational scope
Multi-criteria comparison	Partial, conditional, or aggregated comparison among actions	Which comparisons are warranted under plural values?	Incommensurability, priorities, dominance, unresolved remainder
Uncertainty	Probabilistic, structural, model, historical, implementation, and normative uncertainty	Which comparisons remain supportable under incomplete knowledge?	Deep uncertainty, model disagreement, evidential insufficiency
Sequential decision	Ordered sequences of actions and epistemic events	How does order change reachable histories and later options?	Noncommuting transformations, lock-in, learning, staged commitment
Collective decision	Distributed knowledge, authority, voice, and implementation capacity	How is a decision constituted across multiple subjects and institutions?	Representation, veto, delegation, burden, dissent, accountability
Action-space revision	Transformation of practical possibility through action and epistemic events	How should the decision frame change when options are generated or foreclosed?	Versioning, provenance, reopening, recoupling with inquiry

problem.

Decision analysis in this setting begins from a different object than a fixed menu of alternatives. A practical decision situation is historically produced. Earlier actions, institutional rules, epistemic events, classifications, material transformations, and relations among subjects can determine which options are presently reachable, which remain latent, which have become expensive or illegitimate, and which have disappeared. The decision method therefore analyzes both choice among presently reachable actions and the generative structure through which the action space itself has been formed.

The same point applies to consequences. An action need not map to one terminal outcome. It can initiate, constrain, or reweight a family of later histories, while its implementation can alter the actors, institutions, criteria, and evidential conditions that later decisions inherit. A decision procedure that compresses these effects into one expected score can remain useful in a sufficiently stabilized problem, but such compression becomes a methodological choice whose information loss and normative assumptions should be explicit.

Table 11.7 summarizes the decision architecture developed in this section.

The architecture in Table 11.7 makes decision analysis recursive. A decision is evaluated partly by the histories it can generate, yet the decision process and the resulting action can also transform the domain over which later decisions are made. The method must therefore preserve enough structure to reconstruct how the decision frame changed, why certain alternatives became reachable, and which possibilities were lost.

11.7.1 Decision Situations

A decision method requires a local object of analysis. The broader practical situation reconstructed in Section 267 can contain many problems, actors, time horizons, and possible commitments. A decision situation selects the part of that field for which practical closure is presently being organized. The selection is analytical and institutional at once: it identifies what is to be decided, by whom, under which authority, over which horizon, and with what relation to later revision.

Definition 11.90 (Evolving decision situation). An *evolving decision situation* is a stage-indexed practical configuration in which one or more responsible positions must organize a commitment among presently relevant possibilities while the represented subjects, action space, evidence, criteria, and consequence structure can continue to change.

Definition 11.90 treats the decision situation as stage-indexed because the same practical problem can generate several materially different decisions through time. An early stage may concern whether to investigate further. A later stage may concern a pilot, authorization, scale-up, maintenance, redesign, suspension, or withdrawal. The identity of the decision should therefore be specified through its commitment object and temporal location rather than inferred from the continuing name of the project or institution.

For bookkeeping, a model can represent the decision situation at stage t through the tuple in Equation 11.1.

$$\mathfrak{D}_t = (\omega_t, \mathbf{S}_t, \mathcal{A}_t, \mathbf{C}_t, \mathbf{U}_t, \mathcal{I}_t, H_t). \quad (11.1)$$

In Equation 11.1, ω_t denotes the represented practical configuration; $\mathbf{S}_t$ the relevant subject and institutional positions; $\mathcal{A}_t$ the represented action space; $\mathbf{C}_t$ the criterion architecture inherited from Section 11.3; $\mathbf{U}_t$ the uncertainty structure; $\mathcal{I}_t$ the authority, responsibility, participation, and implementation arrangement; and H_t the relevant decision horizon. The tuple is a model-specific representation rather than a universal ontology. Historical narrative, institutional process maps, participatory records, qualitative case reconstruction, or other forms can perform the same analytical function without being translated into Equation 11.1.

The decision horizon deserves explicit treatment. A short horizon can make temporary stabilization appear attractive while hiding maintenance burdens or later option foreclosure. A long horizon can highlight delayed consequences while increasing uncertainty and model dependence. The method should therefore record both the horizon used for the immediate decision and any longer horizon over which relevant consequences are expected to emerge.

Definition 11.91 (Decision horizon profile). A *decision horizon profile* records the temporal interval over which the present commitment is authorized, the intervals over which material consequences are assessed, the expected timing of new information or review, and any horizon beyond which uncertainty is treated qualitatively or through alternative representations.

Decision situations also have provenance. The practical object may have been framed through an earlier diagnosis, inherited from a legal mandate, generated by an emergency, produced by a prior intervention, or reconstructed after failure. These origins matter because they influence which alternatives appear legitimate

and which questions remain outside the frame. A decision method should therefore preserve a decision-situation record linking the present frame to its preceding problem formulation, diagnosis, goals, criteria, and epistemic events.

A decision situation can itself be performative. Publicly defining a decision as imminent can alter expectations, mobilize opposition, accelerate investment, delay cooperation, or induce actors to reposition before the formal decision occurs. The analytical frame can therefore become one of the events changing ω_t . Where this effect is plausible, the decision record should distinguish the configuration reconstructed before announcement from the configuration observed after the decision process became socially active.

Proposition 11.92 (Decision-situation provenance). *A decision analysis remains reconstructable when the decision object, horizon, practical boundary, responsible positions, inherited criteria, and major epistemic or institutional events that produced the present frame are recorded together with the alternatives considered within that frame.*

The subject positions represented within $\mathfrak{D}_t$ require further specification. The following subsection develops them as historical-relational objects whose practical capacities and identities can themselves change through decision and intervention.

11.7.2 Historical-Relational Subjects

Decision analysis often gains tractability by representing actors as points endowed with preferences, beliefs, resources, or utility functions. Such representations remain legitimate when their simplifications fit the practical question. The GR architecture developed earlier in the book also permits a richer representation in which the subject is historically extended and relationally constituted. This representation becomes especially useful when the decision changes the subject's capacities, institutional standing, internal organization, or relations to other subjects.

Definition 11.93 (Historical-relational decision subject). *A historical-relational decision subject is a decision-relevant representation of a subject that preserves the earlier events, internal organization, external relations, capacities, constraints, roles, and category assignments materially relevant to the present commitment.*

The representation can be narrative, tabular, graph-based, dynamical, agent-based, partially ordered, or higher-order. Where event history and internal relational organization are central, a labeled 2-complex can provide one convenient computational model. Vertices can represent selected event tokens, edges local relations or gluing conditions, faces higher-order compositions, and labels roles, capacities, categories, or provenance. The representation is selected for analytical usefulness; it does not imply that subjects possess a unique underlying 2-complex ontology.

A historical-relational subject has a boundary that can itself be disputed. An organization may be represented as a legal entity, a set of employees, an infrastructure and its users, a chain of contractors, or a field of relations extending beyond the formal organization. A household, community, professional group, or algorithmically mediated collective can similarly have several decision-relevant boundaries. The appropriate boundary depends on the mechanism, responsibility, and consequence under study.

Definition 11.94 (Subject-boundary profile). *A subject-boundary profile records the practical boundary used to represent a subject, the internal and external relations*

retained by that representation, the excluded relations judged less relevant at the current stage, and the conditions under which the boundary should be revised.

This structure matters for preference and criterion analysis. A preference recorded at one time can be a product of earlier constraints, institutional classifications, learned expectations, or unavailable alternatives. Decision analysis can still use the expressed preference, yet its interpretation changes when the subject's historical formation is analytically relevant. The method can distinguish current preference, protected interest, capability, role obligation, and potential future preference rather than compressing them into one stable ordering.

Subjects can also change through epistemic events. Recognition can create standing. Classification can alter eligibility. A forecast can change expectations. A diagnostic label can modify self-understanding or institutional treatment. An AI recommendation can redistribute interpretive authority. In these cases, the subject at stage $t + 1$ is not merely the same subject with one updated belief; the practical relations constituting the subject may have changed.

Definition 11.95 (Subject transformation record). A *subject transformation record* documents a material change in the represented subject's roles, capacities, constraints, relations, category status, internal organization, or practical identity that occurs during the decision process or as a consequence of earlier action.

The same discipline applies to collective subjects. A committee, institution, coalition, or community can develop capabilities and internal relations through the process of deliberation itself. Collective decision therefore cannot always be reconstructed as aggregation over a fixed set of pre-existing individual preferences. Section 11.7.9 returns to this issue after the action and consequence structures have been specified.

Proposition 11.96 (Subject-sensitive decision analysis). *When a contemplated decision can materially alter the capacities, relations, standing, or internal organization of affected subjects, the decision analysis should treat those transformations as part of the consequence structure rather than holding the subject representation fixed by construction.*

Historical-relational subjects act within action spaces that also carry histories. The next subsection distinguishes present reachability from latency and foreclosure while recording how particular actions entered the practical field.

11.7.3 Available, Latent, Generated, and Foreclosed Actions

An evolving decision analysis requires more than a list of candidate actions. Actions differ in present reachability, activation conditions, institutional legitimacy, temporal availability, reversibility, and generative provenance. The action space should therefore preserve both a current status and a history of how an option became possible or impossible.

Definition 11.97 (Decision-relevant action space). A *decision-relevant action space* is the stage-indexed representation of practical actions whose current reachability, activation pathways, constraints, provenance, and potential foreclosure are sufficiently relevant to the present decision to warrant explicit analysis.

Three current-status classes are especially useful. An *available action* is presently reachable under the operative authority, resources, capacities, and timing conditions.

A *latent action* is not presently reachable but possesses a plausible activation pathway through learning, coordination, authorization, resource mobilization, institutional change, or capability development. A *foreclosed action* has lost effective reachability under the present history because a relevant window has closed, a required capacity has disappeared, a commitment has become irreversible, an institution has prohibited the action, or the material configuration has changed.

Generation describes a different property. It records how an action entered the practical field. An action can be generated by earlier learning, coordination, infrastructure, legal reform, technological innovation, recognition of a new actor, creation of a collective capability, or reorganization of the problem itself. A generated action can subsequently become available, remain latent, or later become foreclosed. Treating generation as provenance prevents the analytical mistake of forcing it into the same status axis as current reachability.

Definition 11.98 (Action-status and provenance profile). An *action-status and provenance profile* records for a decision-relevant action its present reachability status, activation requirements, historical source, authority and capacity conditions, temporal window, dependencies, and known pathways through which it could become available, latent, or foreclosed at a later stage.

Formal permission provides only one component of reachability. An action can be legally permitted while practically unavailable because the actor lacks financing, information, coordination partners, institutional competence, time, or credible protection against retaliation. Conversely, an institution can possess substantial practical capacity for an action whose formal authorization is ambiguous. Decision analysis should therefore distinguish nominal possibility from effective reachability, continuing the action-space architecture developed in Section 271.

Latent actions are especially important under uncertainty. Additional inquiry can reveal a latent mechanism, but learning is only one activation route. Participation can generate collective capacity; sequencing can create infrastructure; a temporary intervention can preserve a later option; an institutional reform can make coordination possible; and a change in representation can make a previously invisible action intelligible. Decision analysis should therefore consider actions that can be generated by the process itself where such generation is materially plausible.

Foreclosure also requires provenance. The fact that an action is absent from the present menu does not establish that it was never possible. Earlier delay, investment, institutional commitment, environmental degradation, contractual lock-in, or loss of trust can remove an option. A decision record that preserves these losses can reveal path dependence and can prevent later analysis from treating the surviving menu as historically natural.

Definition 11.99 (Action-space omission risk). *Action-space omission risk* is the practical risk that a decision analysis excludes a materially relevant available, latent, generatable, or recently foreclosed action because the analytical frame treats the current visible menu as exhaustive.

Action generation can also create harmful possibilities. New infrastructure, authority, information, or coordination can expand capacities for coercion, extraction, exclusion, or irreversible transformation. Expansion of the action space therefore remains a descriptive change until evaluated through the criteria, justice architecture, and responsibility relations applicable to the situation.

Proposition 11.100 (Action-space status discipline). *A decision analysis in an evolving field should distinguish current action status from action provenance and should record materially plausible activation and foreclosure pathways when these pathways can alter the comparison among present commitments.*

The decision value of an action depends partly on the histories it can initiate or prevent. The following subsection therefore replaces a single terminal-outcome representation with an action-conditioned consequence and history structure.

11.7.4 Consequence and History Structure

A practical commitment can produce immediate outcomes, delayed effects, institutional adaptation, feedback, subject transformation, and changes in future option spaces. Decision analysis should preserve enough of this temporal structure to distinguish actions whose short-run results appear similar but whose later histories differ substantially.

Definition 11.101 (Action-conditioned history family). For a represented decision situation at stage t , an *action-conditioned history family* is the model-specific set of admissible later histories associated with a contemplated action, including the branches generated by relevant implementation variation, environmental change, actor response, and subsequent epistemic events.

A formal model can denote this family by $\mathcal{H}_t(a)$ for action $a \in \mathcal{A}_t$. Where the model supports comparative weights, Equation 11.2 records a model-indexed history weight.

$$W_t^{(m)}(h \mid a, \mathfrak{D}_t), \quad h \in \mathcal{H}_t^{(m)}(a). \quad (11.2)$$

In Equation 11.2, m identifies the model or representation under which the history family and its weights are constructed. The quantity $W_t^{(m)}$ can represent probability, transition propensity, accessibility, plausibility, simulation frequency, or another explicitly defined quantity. The notation does not require probabilistic semantics. It also permits different models to generate different history families rather than merely different weights over one common set.

The consequence structure extends beyond terminal states. A history can contain changes in material conditions, relations, capacities, institutions, evidence, expectations, categories, responsibility, distribution, and future action spaces. Decision criteria can therefore be applied to a path, a transition, a temporal region, or a transformation of generative capacity rather than only to an endpoint.

Definition 11.102 (Generative consequence profile). *A generative consequence profile* records the materially relevant changes that a contemplated action can induce in immediate outcomes, relations, capacities, constraints, institutions, subject positions, epistemic conditions, and later action spaces across the relevant history family.

This profile is especially important when an action creates infrastructure or institutions that alter later possibilities. A policy, technology, organizational reform, or emergency measure can produce an immediate effect while simultaneously changing who can act, what can be observed, which categories become institutionalized, and which later interventions remain feasible. These secondary transformations belong to the decision object when they are materially relevant, even if the primary goal concerns a narrower outcome.

History families can also merge. Distinct initial actions can converge toward similar later configurations; conversely, a common early action can branch sharply under different implementation conditions. Scenario construction in Section 290 will develop these structures in detail. The present section uses them only to establish the object on which decision comparison operates.

A counterfactual comparison should preserve this history structure. The relevant alternative to action a may be another action, waiting, continuation of an existing arrangement, withdrawal, or a sequence whose first step is additional inquiry. The baseline is therefore a practical history family rather than a featureless condition of “no action.”

Definition 11.103 (Decision counterhistory). A *decision counterhistory* is an explicitly represented alternative history or history family used to compare a contemplated commitment with another reachable or analytically relevant pathway, including continuation, waiting, or withdrawal where these are practical possibilities.

Proposition 11.104 (History-structured consequence analysis). *When materially relevant effects unfold through path dependence, feedback, subject transformation, or changing action spaces, decision comparison should preserve those history structures to the extent required by the practical claim instead of relying solely on terminal-outcome summaries.*

The consequence and history structure supplies the object to which decision criteria are applied. The next subsection specifies that relation without assuming that every criterion can be reduced to the same numerical scale.

11.7.5 Decision Criteria

Section 11.3 distinguished goals, criteria, and thresholds. Decision analysis now applies that architecture to contemplated actions and their history families. The central methodological requirement is criterion-object fit: a criterion should evaluate the practical feature it was designed to represent at the temporal and relational scale on which that feature exists.

Definition 11.105 (Decision criterion application). A *decision criterion application* specifies how an evaluation criterion is applied to an action, process, history, history family, or transformation of practical possibility, together with the temporal horizon, affected positions, evidence basis, and comparison rule required for interpretation.

A safety criterion may apply to worst-case exposure during implementation. A participation criterion may apply to the process by which the action is authorized. A generative-opportunity criterion may apply to the future capabilities left to affected positions. A fiscal or material-resource criterion may apply to cumulative use over a horizon. A recognition criterion may require qualitative interpretation. These examples show why one action can have several decision-relevant representations without any one representation being treated as the complete consequence.

Criteria also differ in practical status. Some operate as protected constraints: alternatives failing them become inadmissible under the current practical architecture. Others support comparison among admissible actions. Some function as monitoring or revision triggers after commitment. The same substantive dimension can occupy different roles at different stages, so the method should record whether a criterion is constitutive, protective, comparative, diagnostic, or adaptive in the present decision.

Definition 11.106 (Criterion-role profile). A *criterion-role profile* records the practical function of each criterion within a decision analysis, including whether it defines admissibility, comparison, priority, monitoring, escalation, revision, or reopening.

Decision criteria can also be history-sensitive. A criterion concerning autonomy may evaluate whether an action increases dependence over time. A criterion concerning reversibility may evaluate the evolution of rollback capacity. A criterion concerning institutional capability may distinguish a temporary surge from durable capacity. A criterion concerning justice may evaluate changes in the distribution of risk and generative opportunity rather than only immediate benefit.

Where a quantitative representation is useful, a criterion can be written as a model-specific functional $C_k^{(m)}$ applied to the relevant object. The notation in Equation 11.3 illustrates this possibility.

$$C_k^{(m)} : (a, \mathcal{H}_t^{(m)}(a), \mathfrak{D}_t) \mapsto Y_k^{(m)}. \quad (11.3)$$

Equation 11.3 leaves the codomain $Y_k^{(m)}$ open. It may be numerical, ordinal, categorical, interval-valued, set-valued, or structured qualitative output. This prevents the notation from silently requiring numerical commensurability.

Criterion evaluation can itself be uncertain. An action can be clearly superior on one dimension, poorly known on another, and incomparable on a third. The decision record should preserve this structure instead of filling every cell with an artificial number. Missingness, model disagreement, and qualitative uncertainty can be represented explicitly and can affect whether deeper commitment is supportable.

Proposition 11.107 (Criterion-object fit). A decision criterion is methodologically informative when its practical role, object of application, temporal horizon, affected positions, evidence basis, and uncertainty are specified at a level appropriate to the substantive dimension it represents.

With criterion applications established, the next methodological problem is comparison across several criteria whose relations can include reinforcement, priority, conditional trade-off, and incommensurability.

11.7.6 Multi-Criteria Decision

Practical decisions commonly involve several criteria that cannot be assumed to lie on one metric scale. Multi-criteria decision analysis in the present framework therefore begins with the criterion architecture from Section 11.3 and asks what form of comparison is warranted by the relations among those criteria.

Definition 11.108 (Multi-criteria comparison architecture). A *multi-criteria comparison architecture* specifies the admissibility conditions, criterion relations, priority rules, permissible conversions or weights, unresolved conflicts, and comparison procedures used to compare contemplated actions across heterogeneous practical dimensions.

Several forms of comparison are available. Dominance can identify an action that performs at least as well across the relevant criteria under the adopted representation and better on at least one dimension. Priority rules can protect criteria judged constitutive or safety-critical. Lexical or staged procedures can evaluate protected constraints before comparative criteria. Partial orderings can leave some pairs unre-

solved. Aggregation can be used where commensurability and weighting have sufficient warrant. Deliberative or interpretive judgment can remain explicit where the practical object resists stable numerical conversion.

A useful first stage is admissibility filtering. Let $\mathcal{A}_t^{\text{reach}}$ denote the presently reachable actions and let $\mathbf{P}_t$ denote the protected criterion conditions. Equation 11.4 defines the corresponding admissible set schematically.

$$\mathcal{A}_t^{\text{adm}} = \left\{ a \in \mathcal{A}_t^{\text{reach}} \mid a \text{ satisfies the protected conditions in } \mathbf{P}_t \right\}. \quad (11.4)$$

Equation 11.4 does not determine a preferred action. It identifies which presently reachable actions remain eligible for further comparison under the current protected conditions. Those conditions can themselves be contested and revisable, so their provenance should remain visible.

Weighting requires particular care. A numerical weight can represent relative importance, a conversion coefficient, a negotiated priority, or a model-specific sensitivity parameter. These meanings should not be conflated. Where weights are used, the method should record their provenance and examine whether the recommendation changes materially across plausible weighting structures.

Definition 11.109 (Decision comparison remainder). *A decision comparison remainder is a materially relevant value, uncertainty, disagreement, loss, or consequence that remains unresolved or insufficiently represented after the adopted multi-criteria comparison procedure has been applied.*

The comparison remainder prevents apparent technical completeness from erasing unresolved practical material. A decision can still close provisionally, but the unresolved remainder should travel with the closure record and can become a monitoring or reopening object.

Multi-criteria analysis can also change the action space. A comparison may reveal that every currently available action performs poorly because the original design space is too narrow. The appropriate methodological response can then be option generation, institutional redesign, sequencing, or renewed inquiry rather than forced selection of the least unsatisfactory visible alternative.

Proposition 11.110 (Plural comparison discipline). *A multi-criteria decision procedure remains aligned with heterogeneous practical values when it uses only the conversions and aggregations supported by the criterion architecture, preserves protected conditions and unresolved remainders, and permits the comparison process to trigger revision of the action space where the existing alternatives are inadequate.*

The remaining uncertainty around actions, histories, criteria, and models can exceed the structure supported by ordinary probabilistic analysis. The next subsection distinguishes uncertainty from deep uncertainty and specifies how decision analysis can proceed without manufacturing precision.

11.7.7 Decision under Uncertainty and Deep Uncertainty

Decision analysis under uncertainty can take many forms. A probability distribution can be informative when the event space, model, parameterization, and empirical basis support probabilistic interpretation. Other situations involve uncertainty about the model itself, the relevant histories, the categories used to describe outcomes, fu-

ture institutional response, implementation capability, or the values that later actors will apply. These forms require a broader architecture.

Definition 11.111 (Decision uncertainty profile). A *decision uncertainty profile* records the materially relevant uncertainty associated with the practical configuration, action status, consequence and history structure, criterion application, model choice, implementation process, affected positions, and future revisions of the decision frame.

Probabilistic uncertainty forms one part of this profile. Parameter ranges, confidence intervals, posterior distributions, simulation ensembles, or empirical frequencies can be useful where their semantics are warranted. Structural uncertainty concerns how the relations or mechanisms are represented. Model uncertainty concerns plausible alternative formalisms. Historical uncertainty concerns incomplete reconstruction of path dependence and earlier events. Implementation uncertainty concerns whether the contemplated intervention will be enacted as represented. Normative uncertainty concerns unresolved values, priorities, or standing.

Definition 11.112 (Deep practical uncertainty). *Deep practical uncertainty* is a condition in which one or more elements required for stable decision comparison—such as the model family, relevant history space, transition weights, consequence categories, implementation response, or criterion ordering—remain materially unsettled across reasonable representations or affected positions.

Deep uncertainty does not eliminate decision. It changes the appropriate form of analysis. The method can compare robustness across models, preserve several pathways, emphasize reversible commitments, use scenario families, impose protective constraints, expand monitoring, delay deeper commitment where learning is valuable, or authorize bounded protective action where waiting itself carries substantial consequence. Sections 292–292 develop these methods in greater detail.

The decision analyst should also distinguish uncertainty from disagreement. Two models can disagree because they encode different assumptions while both are precisely specified. Two affected groups can disagree about values while sharing the same factual model. A dataset can be sparse without there being any substantive disagreement. Preserving these distinctions helps identify whether the appropriate response is additional evidence, model comparison, deliberation, institutional negotiation, or action under acknowledged plurality.

A useful practice under deep uncertainty is to separate conclusions by stability. Some actions may remain admissible across a wide set of models and histories. Some may depend on one contested assumption. Some may be dominated only under a narrow probability assignment. The decision record can therefore report a stability profile instead of a single recommended ranking.

Definition 11.113 (Decision stability profile). A *decision stability profile* records which action comparisons, admissibility judgments, or practical conclusions persist across the materially plausible models, history representations, uncertainty assumptions, and criterion structures considered in the analysis.

Epistemic sufficiency from Section 11.4 remains commitment-relative. Deep uncertainty can be compatible with a small reversible pilot and incompatible with a large irreversible commitment under the same evidence state. The decision method should therefore connect uncertainty to commitment depth instead of seeking one global confidence threshold.

Proposition 11.114 (Uncertainty-sensitive comparison). *When uncertainty concerns the model, history space, implementation structure, or criterion architecture itself, decision analysis should preserve that structural uncertainty in the comparison and evaluate the depth, reversibility, and learning architecture of the contemplated commitment accordingly.*

Decisions also occur in sequences. Because earlier commitments can transform the field and later action space, the order of actions and epistemic events can become analytically consequential.

11.7.8 Sequential and Order-Sensitive Decision

A sequence of individually reasonable actions can produce a different practical trajectory when their order changes. Early investment can create lock-in. Early participation can generate information and legitimacy that change later design. A temporary restriction can preserve time for learning. Premature standardization can foreclose experimentation. An epistemic event occurring before authorization can alter the set of actions considered, while the same information arriving after implementation may function only as a revision trigger.

Definition 11.115 (Decision pathway). A *decision pathway* is an ordered sequence of practical commitments, epistemic events, observations, and review points whose composition changes the configuration inherited by later stages.

Where state-changing transformations are represented by partial operators, order sensitivity can be expressed through composition. Equation 11.5 illustrates a case in which two admissible transformations have different compositions according to order.

$$\Phi_b \circ \Phi_a \neq \Phi_a \circ \Phi_b. \quad (11.5)$$

Equation 11.5 is a model-specific statement of noncommutativity. It can represent different final configurations, different intermediate exposures, different information states, or different domains of later admissibility. The same analytical point can be expressed without operator algebra through process tracing, event histories, institutional sequence analysis, or simulation.

Sequential decision therefore evaluates more than the set of actions eventually taken. It evaluates timing, precedence, staging, gates, feedback, and the conditions under which one step activates or forecloses another. A decision can be valuable because it preserves a later choice, generates information, builds capacity, or delays irreversible commitment until a specified observation becomes available.

Definition 11.116 (Sequencing value). *Sequencing value* is the practical value associated with the order of commitments because that order changes learning, exposure, capacity, coordination, reversibility, or the action space available at later stages.

Order-sensitive analysis also applies to criteria. A protected-rights screen applied before optimization can yield a different admissible set than a procedure that first maximizes an aggregate objective and evaluates rights only afterward. Similarly, problem definition before participation can differ from problem definition after participation. The order in which epistemic and normative operations are performed is therefore part of the method rather than a neutral procedural detail.

A sequential decision architecture should identify review gates. A gate can require a safety observation, participation milestone, capacity condition, financial limit, institutional authorization, or model update before the next commitment becomes available. Gates transform a one-shot decision into a contingent pathway and can preserve reversibility under uncertainty.

Definition 11.117 (Decision gate). A *decision gate* is a specified condition at which continuation, escalation, redesign, suspension, or reversal of a decision pathway is reconsidered using newly available evidence, consequences, capacities, or practical judgments.

Proposition 11.118 (Order-sensitive decision discipline). *When earlier commitments or epistemic events materially change later reachability, exposure, knowledge, or criteria, decision analysis should compare ordered pathways and gate structures in addition to comparing isolated actions.*

Sequential analysis becomes more complex when knowledge, authority, implementation, and exposure are distributed among several subjects. The next subsection treats collective decision as a relational architecture rather than a simple aggregation step.

11.7.9 Collective Decision

Collective decision arises when a practical commitment depends materially on several subjects or institutions whose knowledge, authority, values, implementation capacities, exposure, or rights differ. The collective object can be a committee, organization, partnership, public process, coalition, community, or distributed governance arrangement. Its decision architecture should reflect the relations through which a commitment becomes collectively authorized and enacted.

Definition 11.119 (Collective decision architecture). A *collective decision architecture* specifies the distribution of agenda-setting, evidence production, interpretation, proposal, participation, representation, authorization, veto, implementation, monitoring, review, and revision rights through which a collective practical commitment is constituted.

This architecture extends the participation and institutional analyses of Sections 276 and 279. Collective decision can use voting, consensus, delegated authority, negotiated agreement, professional judgment, participatory deliberation, algorithmically assisted recommendation, or hybrid arrangements. The methodological question concerns fit between the decision object and the rights, knowledge, responsibilities, and affected positions organized by the chosen procedure.

Aggregation of individual preferences can be informative in some settings, but it does not exhaust collective decision. The process can generate new information, transform preferences, create shared categories, build trust, disclose hidden burdens, or produce a collective capability that was absent before deliberation. The collective subject after the decision process can therefore differ materially from the collection of positions represented at its beginning.

Definition 11.120 (Collective decision transformation). A *collective decision transformation* is a material change in shared knowledge, relational organization, trust, capability, standing, or practical orientation generated through the process by which a collective decision is formed.

Collective decisions also have asymmetrical burdens. Some participants provide technical analysis, others experiential knowledge, others implementation labor, and others bear the consequences. Time, language, confidentiality, digital access, organizational hierarchy, or economic dependence can affect whose participation becomes influential. A method that reports only formal voting rights can therefore miss the practical distribution of decision power.

Dissent should remain traceable. A decision can close under legitimate authority while preserving disagreement concerning evidence, values, risk, or expected consequences. The decision record should distinguish the authorized commitment from the distribution of reasons supporting or contesting it. This preserves material that can later become important in evaluation or reopening.

Collective decision can also distribute responsibility across interfaces. If one unit produces evidence, another authorizes action, a third implements, and a fourth monitors, failures can arise in the translations among them. The decision architecture should therefore map not only who holds each role but how information, authority, and responsibility travel between roles.

Definition 11.121 (Collective decision provenance record). A *collective decision provenance record* documents the participating and represented positions, decision rights, evidence and models considered, major disagreements, authorization pathway, implementation responsibilities, and review conditions through which a collective commitment was constituted.

Proposition 11.122 (Collective-decision traceability). A *collective decision remains accountable when the method preserves how distributed knowledge, voice, authority, dissent, implementation capacity, and responsibility were connected in producing the practical commitment*.

Collective decision does not end the evolution of the action space. The final subsection develops explicit revision of that space as a methodological operation.

11.7.10 Revision of the Action Space

The action space represented at the beginning of a decision analysis is provisional. Epistemic events, participation, negotiation, institutional change, implementation learning, material transformation, technological development, conflict, and earlier commitments can generate actions, activate latent actions, or foreclose previous possibilities. Decision methodology should therefore include procedures for revising the action space itself.

Definition 11.123 (Action-space revision). *Action-space revision* is a documented change in the represented set, status, provenance, activation conditions, or dependencies of practical actions in response to materially relevant changes in knowledge, relations, capacities, constraints, institutions, or history.

A schematic update can be represented by Equation 11.6.

$$\mathcal{A}_{t+1} = \mathcal{G}_t(\mathcal{A}_t, \omega_t, e_t, a_t, \Delta \mathbf{S}_t, \Delta \mathcal{I}_t). \quad (11.6)$$

In Equation 11.6, e_t denotes a materially relevant epistemic event, a_t a practical commitment or action, $\Delta \mathbf{S}_t$ a change in subject configuration, and $\Delta \mathcal{I}_t$ a change in institutional or implementation conditions. The update operator $\mathcal{G}_t$ is representation-

specific. A qualitative decision process can perform the same update through an option-generation workshop, participatory redesign, institutional review, historical reconstruction, or expert deliberation.

Revision can occur at several depths. A status revision changes an action from latent to available or from available to foreclosed. A parameter revision changes cost, scale, timing, or implementation conditions. A structural revision adds or removes an action family. A generative revision changes the mechanism through which further actions can be created. A boundary revision changes which actors or institutions are considered capable of action.

Definition 11.124 (Action-space version). An *action-space version* is a dated representation of the decision-relevant actions, their current statuses, activation pathways, provenance, dependencies, and known foreclosure conditions at a specified stage of practical analysis.

Versioning makes path dependence visible. If a later review considers only the current action space, it may interpret an earlier decision as irrational because an attractive option now exists that could not previously be reached. Conversely, an earlier choice can appear unavoidable if later records omit alternatives that were available at the time but were subsequently foreclosed. Action-space versions therefore complement the practical as-of state developed in Chapter 10.

Action-space revision also provides a safeguard against decision procedures that become trapped by their own original framing. If every available action violates a protected condition or performs poorly across the major criteria, the method can re-open diagnosis, search for latent options, generate new institutional combinations, or recouple the practical problem with research-dominant praxis. Forced selection from an inadequate menu is one possible procedural rule, but it is not a general requirement of decision analysis.

Definition 11.125 (Action-space reopening trigger). An *action-space reopening trigger* is a materially relevant development indicating that the current representation of practical possibilities is insufficient for responsible comparison, such as newly generated capacity, severe criterion failure across existing options, discovery of a foreclosed pathway, changed authority, or an epistemic event that alters the underlying practical configuration.

The action-space revision record should preserve why an option was added, activated, modified, or removed; which evidence or practical event motivated the change; which actors gained or lost practical possibilities; and how the revision affects earlier comparisons. This is especially important when institutions later evaluate whether an intervention expanded agency, produced lock-in, or redistributed the capacity to initiate further action.

Proposition 11.126 (Recursive decision analysis). *Decision analysis in an evolving practical field is recursive when it compares present commitments while remaining able to revise the represented subjects, action space, history structure, criteria, and uncertainty profile in response to materially relevant epistemic and practical events.*

The architecture developed in this section establishes the decision object for the next methodological step. A decision situation contains historical-relational subjects, evolving action spaces, action-conditioned history families, plural criteria, uncertainty, sequences, and collective decision structures. Section 290 develops generative history and scenario construction so that these future structures can be explored

without presuming a single forecast or one fixed probability model.

11.8 Generative History and Scenario Construction

Section 11.7 established decision analysis over action spaces whose contents and reachability can change through practical and epistemic events. The present section develops the corresponding methodology for constructing possible continuations of a practical field. Its role is to replace a static catalogue of future states with structured families of histories that preserve path dependence, branching, merging, transformation of subjects and institutions, and revision of the action space itself. The objective is methodological rather than predictive: scenario construction organizes disciplined exploration of how present configurations may develop under specified actions, events, assumptions, and generative rules. The section proceeds through reference histories, alternative history families, counterfactual, adverse, transformative, and long-horizon histories, followed by branching and merging structures, history weights and transition potentials, model plurality, and scenario revision.

A scenario in this framework is not identified with a forecast. A forecast generally places greater emphasis on what is expected to occur under a specified model and evidence state. A scenario can instead be constructed to investigate possibility, mechanism, vulnerability, transformation, or decision sensitivity even when no defensible probability distribution over futures is available. Scenario construction therefore belongs especially naturally to application-dominant praxis under incomplete knowledge: it provides a disciplined way to compare pathways without claiming that the future has already been reduced to a stable probability space.

Definition 11.127 (Generative scenario). A *generative scenario* is a model-relative and revisable construction of one or more admissible histories generated from a specified practical configuration under stated actions, events, assumptions, transition structures, and boundary conditions, together with the provenance and uncertainty required to interpret those histories.

The word *generative* is important. A history can include changes in the subjects, relations, institutions, capacities, constraints, observation regimes, and practical rules through which later histories are themselves generated. A scenario method that holds all of these structures fixed may still be useful for a local question, but that simplification should be explicit rather than inherited silently.

Table 11.8 summarizes the methodological functions developed in this section.

11.8.1 Reference Histories

Scenario construction requires a comparison structure, yet the most familiar or institutionally established trajectory should not acquire privileged epistemic status merely because it has been labeled a baseline. A reference history is therefore defined by function: it provides a transparent trajectory against which alternatives can be compared. Its construction may use continuation of current arrangements, a policy-neutral convention, a central model trajectory, an historically recurrent pattern, or another explicitly justified rule.

Definition 11.128 (Reference history). A *reference history* is a stated model-relative continuation of the present practical configuration used as a comparison path for

Table 11.8: Methodological architecture of generative history and scenario construction.

Component	Primary function	Characteristic discipline
Reference history	Establish a transparent comparison trajectory	Preserve assumptions and avoid treating the reference as destiny
Alternative families	Represent materially different continuations	Keep branching assumptions, mechanisms, and model provenance visible
Counterfactual history	Examine dependence on changed events or interventions	Preserve historical-relational coherence and downstream transformation
Adverse history	Stress-test vulnerability and protection	Explore consequential failure without requiring a single “worst case”
Transformative history	Represent changes in rules, subjects, and institutions	Permit structural and generative-rule change
Long-horizon history	Trace delayed and path-dependent consequence	Preserve option generation, foreclosure, maintenance, and inheritance
Branch/merge structure	Represent divergence and convergence of pathways	Distinguish temporal precedence from structural coupling
History weights	Express model-specific relative transition structure	State semantics explicitly and preserve non-probabilistic alternatives
Model plurality	Compare scenario constructions across formalisms	Preserve disagreement and avoid premature equivalence
Scenario revision	Update histories after episodic or practical events	Version assumptions, branches, weights, and model changes

evaluating changes in actions, events, assumptions, mechanisms, or generative conditions.

The reference history should preserve its construction assumptions. If it assumes continuation of current institutions, that continuation is itself a substantive assumption. If it assumes no new intervention, existing relations, infrastructures, degradation, learning, demographic change, technological development, or institutional adaptation can still generate substantial change. A “no new intervention” reference can therefore remain dynamically active.

Reference construction should also distinguish observational continuation from generative continuation. Extrapolating a measured trend can provide a useful observational reference. A generative reference additionally asks what mechanisms, relations, capacities, constraints, and institutional processes would have to persist for that trend to continue. The two can diverge when the observed pattern depends on conditions that are already changing.

Definition 11.129 (Reference-history provenance). *Reference-history provenance* records the model, data, historical window, continuation assumptions, institutional conditions, boundary choices, and uncertainty through which a reference history was constructed.

A reference history can also be plural. When current evidence supports several materially different continuations, a reference set may be more appropriate than one central trajectory. This avoids allowing an arbitrary “middle” scenario to become the

tacit center of later evaluation.

The practical value of a reference history lies in comparison, diagnosis, and communication. It can reveal what an intervention changes, which mechanisms matter, and which consequences occur even in the absence of the focal action. Its value is weakened when the reference becomes an implicit forecast or a normative default.

Proposition 11.130 (Reference-history discipline). *A reference history should function as an explicit comparison construction whose assumptions and generative dependencies remain revisable; its use does not by itself establish that the represented continuation is the most probable, desirable, or institutionally appropriate future.*

Once a reference structure has been specified, scenario analysis can construct families of alternative continuations rather than isolated deviations around a single path.

11.8.2 Alternative History Families

An alternative scenario is often presented as a different endpoint or a small number of narrative pathways. GR requires a stronger representation when the pathway itself changes future possibility. Two histories can reach superficially similar states while differing in accumulated capacities, institutional memory, exposure, trust, legitimacy, or option spaces. Scenario construction should therefore preserve histories rather than only terminal outcomes.

For a practical configuration ω_t , model m , contemplated action or pathway a , and assumption set Θ , a model-specific family of admissible histories can be represented as Equation 11.7.

$$\mathcal{H}_t^{(m)}(a; \Theta) = \{h \mid h \text{ is admissible from } \omega_t \text{ under } (m, a, \Theta)\}. \quad (11.7)$$

Equation 11.7 is deliberately permissive. A history can be represented by a time-indexed state sequence, a partially ordered event structure, an agent-based simulation trace, an institutional process narrative, a network evolution, a labeled 2-complex, or another locally justified representation. The set of admissible histories can be finite, continuous, generated procedurally, or analytically characterized rather than enumerated.

Definition 11.131 (Alternative history family). *An alternative history family is a set of materially differentiated admissible continuations constructed to examine how changed actions, assumptions, events, relations, or generative rules can alter the practical trajectory.*

Alternative families can be organized around different questions. One family may vary implementation quality while holding goals stable. Another may compare institutional arrangements. A third may explore different epistemic events, technological developments, ecological conditions, or forms of collective response. Scenario design should therefore state the dimension of variation and the structures held provisionally fixed.

An alternative family can also contain endogenous novelty. A history need not be generated by choosing one element from a fixed action list at each stage. Earlier events can generate new actions, new subjects, new institutions, and new observation capacities. The family can consequently expand as the simulated or reconstructed history evolves.

Definition 11.132 (Scenario-generating specification). A *scenario-generating specification* states the initial configuration, model or models, exogenous conditions, endogenous transformation rules, admissible actions, epistemic-event structure, boundary conditions, and stopping or horizon rules used to generate a history family.

The distinction between variation and novelty is methodologically useful. Parameter variation explores different values within a retained architecture. Structural variation alters relations or mechanisms. Generative variation permits the architecture that produces later possibilities to change. These levels can coexist within one scenario programme but should remain distinguishable in its records.

Alternative histories also support decision comparison from Section 11.7. An action can appear favorable in one narrow continuation and fragile across a broader history family. Scenario construction therefore prepares the more explicit robustness analysis of Section 291.

11.8.3 Counterfactual Histories

Counterfactual construction asks how a history could have differed under a changed event, action, relation, or condition. In a generative-relational framework, the changed element should be propagated through the downstream relational structure rather than inserted while every other feature is held artificially unchanged.

Definition 11.133 (Generative counterfactual history). A *generative counterfactual history* is a reconstructed or simulated continuation in which one or more antecedent conditions, events, actions, or relations are altered and the subsequent history is regenerated according to the model's stated dependency and transformation structure.

This definition places a discipline on counterfactual comparison. If an earlier institutional decision changes later capacity, authority, trust, or information, the counterfactual should carry those changes forward where the model represents them. If an epistemic event changes the action space, the counterfactual cannot simply remove the event while preserving the later action menu that the event generated.

Counterfactual histories can serve several practical purposes. They can illuminate mechanism, estimate consequences under a causal model, reconstruct responsibility, examine path dependence, or evaluate whether an apparently necessary outcome depended on contingent earlier decisions. Their evidential standing varies accordingly. A formally identified causal counterfactual and an exploratory historical counterfactual can both be useful while making different warrant claims.

Definition 11.134 (Counterfactual dependency record). A *counterfactual dependency record* identifies which downstream relations, capacities, constraints, institutions, observations, and actions are permitted to change after the counterfactual antecedent is modified, together with the model or reasoning that governs those changes.

Historical-relational subjects require particular care. Removing one formative event from a subject's history may alter the later subject rather than merely alter one attribute of an otherwise fixed entity. A 2-complex or partially ordered representation makes this especially visible: modification of an earlier vertex, edge, or face can change which later extensions remain admissible.

Counterfactual analysis should also preserve uncertainty about historical uniqueness. Several counterfactual continuations may be compatible with the changed antecedent. A family of counterfactual histories can therefore be more faithful than one

reconstructed alternative.

Caution 11.135 (Counterfactual inheritance). A counterfactual history should not inherit downstream structures from the observed history when those structures materially depend on the antecedent that has been changed. Preserving such structures can understate path dependence and create internally inconsistent comparisons.

Counterfactual analysis examines dependence on changed antecedents. Adverse histories shift the question toward vulnerability under consequentially unfavorable developments.

11.8.4 Adverse Histories

Adverse scenario construction explores histories in which materially important harms, failures, losses, or destabilizing conditions emerge. Its methodological role is to stress-test a decision or intervention architecture against consequential failure modes, including those that may be difficult to assign a stable probability.

Definition 11.136 (Adverse history). An *adverse history* is a scenario history constructed to examine materially harmful or practically unacceptable consequences, including their generative pathways, affected positions, propagation structure, detectability, containment, and possibilities for repair or reversal.

An adverse history is not necessarily the statistically least likely or numerically worst trajectory. Under deep uncertainty, such an ordering may not be defensible. Scenario design can instead select adverse histories because they expose a vulnerability, threshold, concentration of risk, correlated failure, institutional bottleneck, or irreversible loss.

Adverse histories can be generated through several routes: failure of a focal intervention, failure of an enabling institution, unfavorable external conditions, strategic response by other actors, observation or model error, cumulative maintenance failure, cascade across interdependent systems, or delayed consequences that become visible only after earlier options have been foreclosed.

Definition 11.137 (Adverse-pathway anatomy). An *adverse-pathway anatomy* records the initiating conditions, propagation mechanisms, amplifying relations, affected positions, warning signals, containment points, recovery capacities, and irreversible residues associated with an adverse history.

This anatomy helps distinguish protection from prediction. A decision can be designed against an adverse pathway even when the pathway lacks a precise probability estimate. Conversely, a low estimated probability does not automatically make a pathway practically negligible when exposure, irreversibility, concentration of burden, or failure of recovery capacity is substantial.

Adverse scenario construction should also include endogenous response. Institutions may learn, actors may adapt, affected subjects may resist, and emergency capacities may be activated. A scenario that freezes response can overstate damage; a scenario that assumes perfect adaptive response can understate vulnerability. The response structure should therefore be represented explicitly.

Proposition 11.138 (Adverse-scenario relevance). *The practical relevance of an adverse history depends on the consequence structure, exposure, propagation, reversibility, and response capacity represented in the scenario in addition to any model-specific estimate of frequency or probability.*

Adverse histories preserve existing practical architecture while stressing its failure modes. Transformative histories examine the stronger case in which the architecture itself changes.

11.8.5 Transformative Histories

Many practical scenarios treat future change as movement within a stable state space. GR also requires histories in which the relevant subjects, institutions, relations, categories, capacities, or generative rules change enough that the earlier representation becomes incomplete. These histories are especially important for structural intervention and long-horizon analysis.

Definition 11.139 (Transformative history). A *transformative history* is a scenario history in which materially relevant structures of practical generation—including subjects, relations, institutions, capacities, constraints, action spaces, observation regimes, or transition rules—undergo change that cannot be represented adequately as parameter variation within the initial practical architecture.

A transformative history can include institutional creation, dissolution, or reconstitution; formation of a collective subject; emergence of a new technology; ecological regime change; transformation of legal standing; development of a new epistemic infrastructure; or changes in the rules through which later options become admissible. Its defining feature is structural reconstitution, not magnitude alone.

Where a model represents practical evolution through a transition rule F_t , a transformative history may require updating the rule itself. Equation 11.8 expresses one schematic possibility.

$$F_{t+1} = \mathcal{T}(F_t, \omega_t, e_t, a_t, \Delta\mathcal{I}_t). \quad (11.8)$$

Equation 11.8 states only that the later generative rule can depend on the prior rule, configuration, epistemic event, action, and institutional change. The representation can be implemented through dynamical systems, agent rules, operator families, graph rewriting, partial-order extensions, institutional process models, or other formalisms. The equation does not imply that one universal rule-update operator governs practical history.

Transformative scenarios should also address representation drift. Categories that were meaningful before the transformation may lose relevance afterward. Measures, criteria, and affected positions can change. A scenario system should therefore permit its observation and evaluation architecture to evolve with the represented field.

Definition 11.140 (Transformative discontinuity). A *transformative discontinuity* is a point or interval in a scenario history at which the prior representation, criterion structure, or generative rule becomes materially inadequate and requires explicit revision for later continuation.

Transformative histories are particularly useful when an intervention seeks to build capacity, create institutions, change dependency relations, or alter future option spaces. In such cases, evaluating only immediate outcomes can miss the principal object of intervention.

The methodological challenge becomes greater over long horizons, because delayed effects and changing representations accumulate across several generations of

practical configuration.

11.8.6 Long-Horizon Histories

Long-horizon scenario construction extends practical analysis beyond the immediate decision cycle. Its central difficulty is not merely forecasting further into the future. The relevant relations, institutions, subjects, values, technologies, and observation systems may themselves change as the horizon extends.

Definition 11.141 (Long-horizon practical history). A *long-horizon practical history* is a scenario history constructed across a temporal span in which delayed consequences, maintenance, path dependence, institutional succession, option generation or foreclosure, and transformation of practical conditions become materially relevant to present judgment.

Long horizons require attention to temporal layering. Some effects appear rapidly while others accumulate slowly. A decision can create immediate benefit and long-run maintenance burden. Capacity can initially expand and later erode. A temporary institution can become entrenched. An intervention can preserve short-run stability while narrowing future generative opportunity.

Long-horizon analysis should therefore track inherited conditions. These can include infrastructure, debt, ecological state, organizational memory, standards, rights, dependency structures, data archives, unresolved harm, and the action spaces left to later subjects. The object handed forward is a configuration rather than a scalar outcome.

Definition 11.142 (Inter-horizon carryover). *Inter-horizon carryover* is a condition, relation, capacity, constraint, institution, obligation, epistemic resource, or option-space transformation generated in one temporal horizon that materially shapes practical possibility in a later horizon.

Scenario construction can use nested horizons rather than one very long undifferentiated interval. Near-term histories may support detailed operational representation. Medium-horizon histories can emphasize institutional adaptation and capacity. Long-horizon histories may use broader structural variables, boundary conditions, and transformative branches. These representations can be linked without pretending that the same degree of precision is warranted across all horizons.

Long-horizon scenarios should also preserve future epistemic agency. Later subjects may possess knowledge, technologies, values, and institutional forms unavailable now. Present scenarios can model conditions for future revision rather than attempting to decide every later action in advance.

Proposition 11.143 (Long-horizon openness). *Long-horizon scenario construction should represent inherited constraints and generated possibilities while preserving explicit space for future epistemic events, institutional change, and practical revision whose content cannot be determined from the present evidence state.*

The histories considered so far can diverge and transform. The next subsection develops explicit branching and merging structures for representing these relations among histories.

11.8.7 Branching and Merging Structures

A set of independent scenario narratives can obscure shared prefixes, common bottlenecks, convergence, and recombination. Branching and merging structures make these relations explicit. Branching represents divergence after an event or decision. Merging represents later convergence of distinct histories into a shared configuration or equivalence class at the resolution relevant to the analysis.

Definition 11.144 (Scenario branching point). A *scenario branching point* is an event, decision, condition, or transformation after which two or more materially distinct admissible continuations are represented within the scenario architecture.

Definition 11.145 (Scenario merging point). A *scenario merging point* is a represented convergence at which histories with different earlier trajectories enter a common later configuration or become equivalent with respect to the distinctions retained by the model.

Merging requires interpretive care. Two histories can produce similar measured outputs while preserving different institutional memory, legitimacy, distributional consequence, or latent capacity. A merge should therefore be defined relative to an explicit equivalence criterion. Histories can merge for one decision problem and remain distinct for another.

Partially ordered event structures can represent concurrent developments without forcing an artificial total chronology. A labeled 2-complex can provide a richer representation when vertices, edges, and faces encode events, relational couplings, and higher-order composed structures. In such a representation, branching corresponds to alternative admissible extensions, while merging can be represented through later attachments that join previously differentiated structures. This remains a computational choice rather than a claim that practical reality possesses one privileged combinatorial form.

Definition 11.146 (Branch–merge scenario graph). A *branch–merge scenario graph* is a directed or partially ordered representation whose nodes or higher-order structures encode practical configurations or events and whose admissible extensions represent divergence, convergence, and recombination among scenario histories.

Branching and merging also support decision gates. A reversible pilot can create several branches depending on observed effects. Several branches can later merge if different pathways produce sufficiently similar institutional or practical conditions. This structure makes explicit the option value of preserving multiple pathways before a later commitment.

A scenario method should record branch provenance: which action, epistemic event, assumption, or external condition generated the branch. Otherwise later users can see the alternative without knowing why it exists. The same principle applies to pruning. Removing a branch from active analysis should leave a record of the reason, evidence, and scope of the pruning decision.

The structural architecture of histories can be enriched further when the model supports relative weights or transition potentials among admissible continuations.

11.8.8 History Weights and Transition Potentials

Scenario construction does not require all admissible histories to have equal standing. Some models support a relative ordering, nonnegative weight, transition propen-

sity, accessibility measure, simulation frequency, or probability over histories. Section 11.4 introduced this idea for epistemically mediated reweighting. The present subsection develops its use in scenario methodology.

Let $\mathcal{H}_t^{(m)}$ denote the admissible history family under model m . A nonnegative model-specific history-weight function can be written as Equation 11.9.

$$W_t^{(m)} : \mathcal{H}_t^{(m)} \longrightarrow \mathbb{R}_{\geq 0}. \quad (11.9)$$

Equation 11.9 does not determine the semantics of $W_t^{(m)}$. The model must state whether the value represents probability, plausibility, accessibility, transition propensity, empirical frequency, simulation mass, or another quantity. Normalization to one is appropriate only when probability semantics and the corresponding assumptions are justified.

A local transition-potential representation can instead attach a model-specific quantity to an admissible extension from configuration ω to ω' . Equation 11.10 gives a schematic form.

$$K_t^{(m)}(\omega' \mid \omega, e, a) \geq 0. \quad (11.10)$$

Equation 11.10 can encode local accessibility or transition propensity conditional on an epistemic event e and action a . Composition of local transition potentials into history weights depends on the chosen model. Markovian multiplication is one possibility, while path-dependent, non-Markovian, operator-valued, or simulation-based constructions may require different composition rules.

Definition 11.147 (History-weight semantics). *History-weight semantics* is the explicit interpretation assigned to a scenario weight or transition potential, including its domain, normalization properties, update rule, empirical relation, and admissible use in practical comparison.

Epistemic events can alter weights while preserving the history family, or they can change the family itself. An observation may increase the relative support for one mechanism. Institutional recognition may create a new branch. A new technology may generate histories absent from the earlier representation. Scenario revision should therefore distinguish *reweighting* from *history-space transformation*.

Amplitude-like constructions remain possible as a stronger modeling option. Such a model would require semantics for composition, phase, interference, observation, and empirical interpretation that go beyond the nonnegative weights in Equation 11.9. A 2-complex representation of history, including one inspired by spin-foam formalisms, does not by itself supply those semantics. Where amplitude-like quantities add analytical value and their interpretation is justified, they can be developed as a distinct model family rather than treated as the default scenario formalism.

Proposition 11.148 (Weight-interpretation discipline). *A scenario weight should be used in practical comparison only to the extent supported by its stated semantics, empirical relation, and update rule; numerical form alone does not justify probability interpretation or commensuration across models.*

Different scenario models can therefore produce different history spaces, branch structures, and weight semantics. The next subsection treats this plurality directly.

11.8.9 Scenario Model Plurality

Scenario construction can be carried out through historical narratives, participatory scenarios, causal models, dynamical systems, networks, agent-based simulations, formal transition systems, operator models, field models, partial-order event structures, 2-complexes, statistical ensembles, or hybrid architectures. These representations answer different questions and preserve different kinds of structure.

Definition 11.149 (Scenario model family). A *scenario model family* is a class of scenario constructions sharing a representation language, transition logic, evidential interface, and interpretation of histories while permitting variation in parameters, initial conditions, assumptions, or local structures.

Model plurality matters because scenario differences can arise from assumptions inside one model or from different models of the practical field. These sources of divergence should not be conflated. Parameter disagreement within a common causal model differs from disagreement between a causal graph and an institutional-historical account about what structure is relevant.

Scenario comparison therefore requires a correspondence architecture rather than a presumption of equivalence. Models can sometimes be aligned around shared events, actors, constraints, outcomes, or decision-relevant questions even when their internal state spaces differ.

Definition 11.150 (Cross-model scenario correspondence). A *cross-model scenario correspondence* is a documented mapping between selected objects, events, consequences, or practical distinctions represented in different scenario models, used to support comparison without asserting identity between the models.

Convergence across models can strengthen confidence in a practical conclusion when the models are genuinely heterogeneous and share enough common object structure for the comparison to be meaningful. Divergence can be equally informative. It can identify hidden assumptions, boundary sensitivity, different historical reconstructions, or mechanisms that one representation cannot express.

A plural scenario programme should also preserve models that resist integration. Qualitative testimony about institutional fear, for example, may carry practical significance that a quantitative transition model cannot represent adequately. Conversely, a dynamical simulation can reveal feedback patterns difficult to infer from narrative evidence alone. Method combination can coordinate these insights while preserving their different epistemic functions.

Definition 11.151 (Scenario-model remainder). A *scenario-model remainder* is a materially relevant object, relation, uncertainty, value, or consequence represented in one scenario model that lacks a justified correspondence in another model used within the same practical analysis.

Scenario-model remainders should remain visible because apparently convergent conclusions may rest on omitted dimensions. They also identify priorities for future inquiry or method development.

Scenario construction is therefore a living methodological object. New evidence, practical events, or model failures can require revision of the histories themselves.

11.8.10 Scenario Revision

A scenario system constructed at time t can become inadequate as the practical field changes. New observations can alter transition weights. Epistemic events can create new branches. Implementation can transform subjects and institutions. A previously latent pathway can become available, while delay or irreversible commitment can foreclose another. Scenario revision provides the methodological machinery for preserving continuity while updating these structures.

Definition 11.152 (Scenario revision). *Scenario revision* is the documented modification of one or more reference histories, history families, branching structures, model assumptions, transition rules, weights, horizons, or represented objects in response to materially relevant epistemic or practical change.

Revision can occur at several levels. A *weight revision* changes relative support within a retained history family. A *branch revision* adds, removes, splits, or merges scenario branches. A *structural revision* changes relations, mechanisms, or subject representation. A *rule revision* changes the generative logic that produces later histories. A *model revision* replaces or supplements the scenario model family itself.

These revisions should be versioned. A later scenario should not silently overwrite an earlier one, because earlier decisions may have been reasonable relative to the information and histories available at that time. Preserving versions supports responsibility, learning, and post-action re-epistemization.

Definition 11.153 (Scenario revision record). A *scenario revision record* documents the prior scenario version, triggering event or evidence, changed assumptions or structures, added or removed histories, weight changes, model changes, decision implications, responsible positions, and remaining uncertainty associated with a revision.

Revision also requires discipline against hindsight compression. Once one history has occurred, it can appear retrospectively inevitable. The scenario archive should preserve alternatives that were materially admissible earlier, including branches that later became foreclosed. This protects historical analysis from rewriting prior action spaces around the realized path.

Scenario revision can itself be performative. Publishing a new scenario may alter expectations, coordination, investment, institutional attention, or political feasibility and thereby change the future field represented by the scenario. The scenario system should therefore record materially important dissemination and uptake where these effects are plausible.

Proposition 11.154 (Revisable scenario architecture). *Scenario methodology should preserve a versioned relation among histories, assumptions, models, epistemic events, practical transformations, and decision implications so that later revision can change the scenario architecture without erasing the conditions under which earlier judgments were formed.*

Generative scenario construction therefore produces more than a set of possible futures. It produces an explicit architecture of reference, divergence, counterfactual dependence, adverse propagation, structural transformation, long-horizon carryover, branching and merging, weighted transition structure, model disagreement, and revision. The next methodological task is to ask which decisions remain supportable across these heterogeneous histories and representations. Section 291 develops that problem through robust decision-making across histories and models.

11.9 Robust Decision-Making across Histories and Models

Section 11.8 developed scenario construction as a disciplined exploration of reference, alternative, counterfactual, adverse, transformative, and long-horizon histories. The present section develops the decision methodology required when those histories remain multiple, when different models construct them differently, and when practical judgment must proceed without reducing uncertainty to one probability distribution. Its role is to specify robustness as a structured relation between contemplated commitments and the ranges of histories, models, values, scales, and historical trajectories across which those commitments remain practically supportable. The objective is neither to identify one universally optimal action nor to privilege conservative choice. It is to determine where support for a practical commitment persists, where it becomes conditional, and where the decision depends materially on assumptions that remain contestable. The section proceeds through robustness, satisficing, minimax and regret, multiple models, multiple history representations, deep uncertainty, robustness across values, robustness across scales, and robustness across historical trajectories.

Robustness in this framework is therefore plural and indexed. A decision can be robust with respect to one source of variation and fragile with respect to another. An intervention can perform acceptably across many model specifications while depending on one disputed value priority. A strategy can be stable at the organizational scale while transferring vulnerability to another institution or population. A short-run policy can remain effective across many immediate histories while progressively foreclosing future options. Methodologically responsible robust decision-making should preserve these differences rather than compress them prematurely into a single robustness score.

Definition 11.155 (Robust practical support). *Robust practical support* is the persistence of sufficient practical warrant for a contemplated commitment across a stated range of materially relevant variations in histories, models, assumptions, values, scales, or historical conditions, together with an explicit account of the dimensions across which that support weakens, fails, or remains unresolved.

The term *sufficient* refers back to the commitment-relative architecture of Section 11.4. Robustness does not erase uncertainty. It asks whether a commitment remains supportable while uncertainty is represented in several materially plausible ways.

Table 11.9 summarizes the methodological architecture developed in this section.

11.9.1 Robustness

Robustness is meaningful only relative to a stated domain of variation. The phrase “robust option” is incomplete when the analyst does not specify what is being varied, which properties are expected to remain stable, what counts as acceptable performance, and over which temporal and relational horizons the comparison is made. The same action can be robust to parameter variation while fragile to institutional change, robust to one model family while fragile to another, or robust in aggregate while imposing severe losses on a particular affected position.

Table 11.9: Methodological architecture of robust decision-making across histories and models.

Component	Primary function	Characteristic discipline
Robustness	Test persistence of practical support	State the domain of variation and preserve fragility
Satisficing	Identify acceptable rather than uniquely optimal options	Use explicit adequacy and protection conditions
Minimax/regret	Examine adverse performance under defined losses	Restrict use to justified comparison structures
Multiple models	Compare support across model families	Preserve model disagreement and model-specific semantics
History representations	Compare pathways across different history formalisms	Use correspondence without asserting representational equivalence
Deep uncertainty	Act when model, history, or criterion structure is unstable	Favor bounded commitment, learning, and reversibility where appropriate
Values	Test support across plural value configurations	Preserve protected values, partial orders, and unresolved remainders
Scales	Examine cross-scale stability and burden transfer	Distinguish local robustness from systemic robustness
Historical trajectories	Test support across path-dependent development	Evaluate option preservation, lock-in, and generative consequence

Let $\mathcal{D}$ denote a model-specific family of decision contexts. A context $d \in \mathcal{D}$ can index a model, assumption set, history family, value configuration, scale, temporal horizon, or another relevant combination. Let $A(a, d)$ denote whether action a remains practically acceptable in context d according to the applicable criterion architecture. The robustness-support set of a can then be represented as Equation 11.11.

$$\mathcal{R}(a) = \{d \in \mathcal{D} \mid A(a, d) = 1\}. \quad (11.11)$$

Equation 11.11 is intentionally modest. It does not require a scalar robustness score, a probability distribution over contexts, or identical outcome spaces across models. The acceptability relation can itself be composite and may include protected constraints, qualitative judgments, partial orderings, or model-specific requirements. Where acceptability is graded rather than binary, the same architecture can be represented through a richer codomain.

Definition 11.156 (Robustness domain). A *robustness domain* is the explicitly specified family of models, histories, assumptions, value configurations, scales, temporal horizons, and other materially relevant variations across which the support for a contemplated commitment is examined.

A robustness analysis therefore begins with boundary discipline. Excluding a plausible institutional failure, an affected subject, a long horizon, or an alternative model can create apparent robustness by construction. Conversely, including implausible or irrelevant perturbations can make every action appear fragile. The robustness domain should be justified by the practical diagnosis, evidence architecture, scenario

construction, and consequences of error.

The analysis should also distinguish *performance robustness* from *structural robustness*. Performance robustness concerns whether relevant goals or criteria remain acceptably satisfied. Structural robustness concerns whether the action remains implementable, governable, monitorable, revisable, and institutionally coherent when the practical field changes. An intervention whose numerical outcome is stable but whose implementation requires one brittle institution may have high performance robustness and low structural robustness.

Definition 11.157 (Robustness profile). A *robustness profile* records the dimensions across which practical support persists, weakens, becomes conditional, or fails, together with the assumptions, histories, models, values, scales, and temporal horizons associated with those changes.

This profile should preserve fragility. A decision process gains little by reporting that an option is “robust overall” if one particular failure mode dominates the consequences. Robustness is therefore best treated as a structured map of stability and sensitivity rather than a rhetorical label attached to a favored option.

Proposition 11.158 (Robustness-boundary discipline). A *claim of robust practical support* is warranted only relative to an explicit robustness domain and an explicit criterion of persistence; changing either can change the robustness judgment without any contradiction in the underlying analysis.

One consequence is that robust decision-making often seeks a region of acceptable commitments rather than a uniquely best point. The next subsection develops this satisficing orientation.

11.9.2 Satisficing

When values are plural, models disagree, and histories remain open, a decision methodology can often justify an *acceptable region* more credibly than a unique optimum. Satisficing in this section refers to the identification of actions or pathways that satisfy the relevant adequacy, protection, feasibility, legitimacy, and revision conditions at a level sufficient for the contemplated commitment.

Definition 11.159 (Satisficing region). A *satisficing region* is the set of contemplated actions or pathways that satisfy the applicable protected conditions and meet the specified adequacy requirements within a stated robustness domain.

Let $\mathcal{A}_t^{\text{reach}}$ denote the effectively reachable action space from Section 11.7, and let $\mathcal{C}$ denote a collection of admissibility and adequacy conditions. A schematic satisficing region can be written as Equation 11.12.

$$\mathcal{A}_t^{\text{sat}}(\mathcal{D}) = \left\{ a \in \mathcal{A}_t^{\text{reach}} \mid a \text{ satisfies } \mathcal{C} \text{ across the required portion of } \mathcal{D} \right\}. \quad (11.12)$$

The phrase “required portion” in Equation 11.12 is deliberately open. Some protected conditions may be required across the entire robustness domain. Other criteria may permit bounded exceptions, context-specific adaptation, or conditional branches. A high-consequence irreversible commitment can appropriately demand a stronger form of cross-context acceptability than a reversible trial.

Satisficing should not be interpreted as accepting mediocrity. Its methodological

function is to prevent unsupported precision. If several options satisfy the relevant protected and adequacy conditions and the evidence does not warrant a unique ranking among them, declaring one option “best” can add apparent decisiveness without adding knowledge.

Satisficing can also support plural practical values. One criterion can set a safety floor, another a participation condition, another an implementation requirement, and another a minimum capacity-preservation condition. Some of these requirements may be noncompensatory. Superior performance on one dimension does not automatically license violation of another.

Definition 11.160 (Protected satisficing condition). *A protected satisficing condition is an adequacy or admissibility requirement that cannot be offset within the current decision architecture merely by superior performance on another criterion.*

The resulting decision problem can remain underdetermined after satisficing. That is methodologically acceptable. The remaining choice can be resolved through deliberation, sequence design, option preservation, randomization where appropriate, local judgment, or further inquiry. The key requirement is that the method disclose where the evidence and criteria cease to determine the choice.

Satisficing also interacts with action-space generation. When no current option enters the satisficing region, the appropriate response need not be selection of the least inadequate existing option. It may be to generate a new action, alter a constraint, build capacity, redesign the institution, or sequence several partial actions. Robust decision-making therefore retains the generative action-space logic of Section 11.7.

Proposition 11.161 (Generative satisficing). *Failure of all currently reachable options to satisfy the protected practical conditions can constitute a reason to expand or transform the action space rather than a reason to select the highest-ranked unacceptable option.*

Satisficing provides one way to avoid unsupported optimization. Minimax and regret methods provide another family of tools, particularly when adverse performance can be represented coherently.

11.9.3 Minimax and Regret

Minimax and regret constructions can be useful when the practical problem supports a sufficiently well-defined loss or performance relation across a stated uncertainty domain. Their strength is transparency about adverse cases. Their limitation is that the apparent rigor of a worst-case rule can conceal strong assumptions about what counts as loss, which contexts belong to the comparison domain, and whether the losses are commensurable.

Suppose that, for a particular local problem, a model-specific loss function $L_d(a)$ is justified for context $d \in \mathcal{D}$. A minimax action can be represented as Equation 11.13.

$$a^{\text{mm}} \in \arg \min_{a \in \mathcal{A}_t^{\text{adm}}} \sup_{d \in \mathcal{D}} L_d(a). \quad (11.13)$$

Equation 11.13 is appropriate only where the loss semantics and the robustness domain are defensible. It should not be treated as the default GR decision rule. A single extreme context can dominate the result, and that dominance may or may not be practically appropriate.

Regret shifts the comparison from absolute loss to the difference between the performance of an action and the best attainable performance within each context. When the relevant performance relation is numerical and comparable, context-specific regret can be represented as Equation 11.14.

$$\text{Reg}_d(a) = L_d(a) - \inf_{a' \in \mathcal{A}_t^{\text{adm}}} L_d(a'). \quad (11.14)$$

A minimax-regret rule then seeks an action with comparatively limited worst-case regret. This can be useful where decision-makers care about avoiding large ex post opportunity loss across plausible contexts.

Definition 11.162 (Regret interpretation record). A *regret interpretation record* specifies the loss or performance relation, comparison set, uncertainty contexts, temporal horizon, affected positions, and assumptions through which a regret quantity acquires practical meaning.

Both minimax and regret analysis can become misleading when a single scalar loss function erases value heterogeneity or distribution. A policy can have low aggregate regret while repeatedly assigning severe burdens to one group. Likewise, a minimax rule can become excessively conservative when the modeled worst case is structurally implausible or when avoiding it forecloses important future capability.

A GR-compatible use of these methods therefore treats them as *local lenses*. They can illuminate exposure to adverse contexts, but they remain embedded within a wider practical architecture containing protected values, distribution, reversibility, participation, responsibility, and action-space effects.

Proposition 11.163 (Local status of minimax and regret). *Minimax and regret methods can contribute to robust decision-making when their comparison domain and loss semantics are locally justified; their formal completeness does not by itself establish the completeness of the practical judgment.*

The need for local justification becomes stronger when several models organize the same practical problem differently.

11.9.4 Multiple Models

Model plurality is not merely a technical inconvenience to be removed before decision. Different models can preserve different mechanisms, timescales, actor structures, uncertainty forms, or institutional relations. Robust decision-making should therefore ask whether practical support survives across materially relevant model families and, where it does not, which modeling commitments generate the disagreement.

Definition 11.164 (Model-robust support). *Model-robust support* is the persistence of practical support for a contemplated commitment across a stated family of models whose differences are materially relevant to the decision problem.

A model family should not be constructed by superficial variation alone. Several parameterizations of one model architecture can provide useful sensitivity analysis, but they do not represent the same kind of pluralism as disagreement between, for example, a dynamical model, an institutional-historical reconstruction, and an agent-based model with endogenous adaptation.

For each model $m \in \mathcal{M}$, the analysis can produce a model-specific support relation

$A_m(a)$, history family $\mathcal{H}^{(m)}(a)$, and uncertainty profile. The resulting comparison can be organized through a *model support matrix* rather than one aggregated score.

Definition 11.165 (Model support matrix). A *model support matrix* records, for each contemplated action and each materially relevant model, the applicable support judgment, principal assumptions, uncertainty, failure modes, and reasons for disagreement with other models.

Disagreement among models can have several sources. Models can differ in boundaries, state variables, actor representations, causal mechanisms, temporal resolution, endogenous adaptation, observation regimes, or criterion mappings. The robust-analysis task is therefore explanatory as well as comparative: the decision-maker should understand *why* model support differs.

Model disagreement can sometimes be resolved by evidence. In other cases, the models express alternative representations whose difference is not reducible to one missing parameter. Robust decision-making should preserve such unresolved plurality when the practical decision must nevertheless proceed.

A useful distinction is between *intersection robustness* and *conditional robustness*. Intersection robustness identifies options supported across the entire stated model family. Conditional robustness identifies options supported only under specified model classes or assumptions. The latter is not a failure of analysis; it reveals where the decision depends on unresolved modeling commitments.

Proposition 11.166 (Model-disagreement value). *Persistent disagreement across well-specified models can be practically informative because it identifies assumptions, mechanisms, boundaries, or representations on which the decision materially depends; robust analysis should therefore explain model disagreement rather than automatically average it away.*

Models can also disagree more fundamentally in how they represent history itself. The next subsection treats this representational plurality.

11.9.5 Multiple History Representations

Section 11.8 allowed histories to be represented as temporal trajectories, partially ordered event structures, institutional narratives, simulation traces, networks, labeled 2-complexes, or other forms. Robust decision-making should preserve this plurality because the same practical history can reveal different vulnerabilities depending on how temporal, relational, and higher-order structure is represented.

A time-series model can make cumulative change visible while suppressing event order beyond time index. A partial-order representation can preserve generative precedence without forcing unrelated events into one total sequence. A network history can reveal changing dependency structure. A 2-complex representation can preserve higher-order relational and historical composition. A narrative institutional reconstruction can preserve meaning, authority, and context difficult to encode in a compact state representation.

Definition 11.167 (Representation-robust support). *Representation-robust support* is the persistence of relevant practical support after the same decision problem has been reconstructed through several justified history representations that preserve materially different structures.

Cross-representation comparison requires a correspondence map or another trans-

lation discipline. Such a correspondence should identify which events, relations, outcomes, or criteria can be compared and which cannot. The absence of a justified translation is itself information.

Definition 11.168 (Robustness correspondence record). A *robustness correspondence record* documents the objects treated as comparable across history representations, the translation rule used, the information lost or added by that translation, and the practical claims that remain representation-dependent.

Robustness across representations does not mean that all representations should yield identical conclusions. A representation can disclose a path dependency or relational asymmetry that another omits. The analysis should distinguish contradiction from complementarity. Two representations can support the same action for different reasons, or they can disagree because one preserves a structure that the other intentionally abstracts away.

A practical decision becomes especially fragile when its support depends on a feature visible only in one narrow representation and disappears under several reasonable alternatives. Conversely, support that persists across representations with different failure modes can justify stronger confidence in the practical architecture, even when no single representation is treated as ontologically privileged.

Proposition 11.169 (Representational robustness). *Support that persists across several materially distinct and locally justified history representations can provide stronger practical warrant than support that depends on one representation alone, while remaining conditional on the adequacy of the correspondence used for comparison.*

When uncertainty concerns not only parameters or representations but the structure of the problem itself, robust decision-making enters the domain of deep uncertainty.

11.9.6 Deep Uncertainty

Deep uncertainty arises when the practical disagreement concerns the architecture used to describe the future, rather than only unknown values inside a stable model. The uncertain object can include the relevant model family, history space, transition structure, probability semantics, criterion ordering, action space, affected positions, or future generative rules.

Section 11.7 defined *deep practical uncertainty* as a condition in which elements required for stable decision comparison remain materially unsettled across reasonable representations or affected positions. The present subsection does not redefine that concept. It develops the corresponding robustness methodology by examining which practical commitments remain supportable while those structural uncertainties are preserved.

Definition 11.170 (Deep-uncertainty robustness profile). A *deep-uncertainty robustness profile* records how the practical support for a contemplated commitment changes across materially plausible variations in model structure, history space, transition semantics, criterion organization, action-space constitution, and future generative conditions.

Under deep uncertainty, assigning a precise distribution to all futures can produce false precision. Robust methods can instead organize several families of plausible structures and ask which commitments remain supportable across them. The output

may be a bounded action, an adaptive pathway, an option-preserving intervention, a monitoring architecture, or a decision to generate additional capacity before deeper commitment.

A useful methodological object is a *deep-uncertainty ledger*. It records which elements are uncertain, whether the uncertainty concerns parameters or structure, what evidence could reduce it, what cannot currently be resolved, and which commitments are sensitive to it.

Definition 11.171 (Deep-uncertainty ledger). A *deep-uncertainty ledger* records structural and parametric uncertainties separately, identifies their practical consequences, and links them to monitoring, inquiry, adaptation, protection, and reopening conditions.

Deep uncertainty also makes the distinction between *robustness* and *rigidity* important. A rigid decision can perform acceptably under the modeled scenarios while lacking any capacity to respond when an unmodeled mechanism appears. A robust practical architecture often contains adaptive capacity, redundancy, diversity, slack, reversible commitment, or institutional learning precisely because the model space is incomplete.

This does not imply that deeper uncertainty always favors smaller or slower action. Urgent protective action can be warranted under deep uncertainty when delay itself creates severe exposure. The robust design question concerns the structure of commitment: scope, duration, reversibility, monitoring, escalation, de-escalation, and preservation of future options.

Proposition 11.172 (Deep-uncertainty response). *Under deep practical uncertainty, robust decision-making should evaluate the adaptability and learning capacity of the decision architecture itself in addition to the modeled performance of the initial action.*

This proposition prepares Section 292, but robustness must first be extended beyond epistemic variation to value plurality.

11.9.7 Robustness across Values

A decision can appear robust only because one value ordering has been fixed in advance. Section 11.3 established that practical goals and criteria can remain plural, partly ordered, and incompletely commensurable. Robust decision-making should therefore ask whether support for an action persists under materially plausible value configurations and where it depends on contested priorities.

Definition 11.173 (Value-robust support). *Value-robust support* is the persistence of practical acceptability across a stated family of value configurations, priority structures, protected conditions, or criterion interpretations relevant to the decision.

Value robustness does not require moral consensus. It can identify a set of actions that remain acceptable from several divergent value positions while preserving disagreement about the reasons for support. Such overlap can be practically important in collective decision-making because it permits coordinated action without pretending that the underlying normative disagreement has disappeared.

Where support diverges, the analysis should identify the decisive value dependency. One action may be preferred only when efficiency is assigned priority over reversibility. Another may remain acceptable only if a strong protection constraint is applied to one affected group. Another may depend on a particular intergenerational

weighting. These dependencies belong in the robustness profile.

Robustness analysis should also preserve noncompensatory values. If a protected right, safety condition, or justice constraint is constitutive of practical acceptability, superior aggregate performance elsewhere should not automatically offset its violation. A value robustness procedure can therefore use partial orders, protected constraints, lexicographic priorities where justified, or sets of admissible value configurations rather than one weighted sum.

Definition 11.174 (Value-dependence frontier). A *value-dependence frontier* identifies the points at which the practical support for an action changes because a value priority, protected condition, criterion interpretation, or trade-off structure changes.

This frontier can be more informative than a single social objective function. It shows decision-makers and affected subjects which normative commitments are doing the work in the practical conclusion.

The analysis should also retain a *value remainder*: important values, losses, or disagreements that the robustness procedure does not represent adequately. Preserving such remainders is especially important when the decision will later be evaluated under a changed normative or institutional environment.

Proposition 11.175 (Value-plural robustness). A *practical commitment can possess robust support across plural values without those values being rendered commensurable, provided the comparison architecture makes protected conditions, value dependencies, unresolved conflicts, and revision conditions explicit.*

The same discipline is required across spatial, organizational, ecological, and social scales.

11.9.8 Robustness across Scales

A decision that appears robust at one scale can be fragile or harmful at another. An organizational intervention can stabilize local performance by transferring costs to front-line workers. A regional system can become more reliable by concentrating dependencies on one national infrastructure. A short supply chain can become resilient for one actor by displacing ecological or social exposure elsewhere. Robust decision-making therefore requires an explicitly multiscale analysis.

Definition 11.176 (Cross-scale robustness). *Cross-scale robustness* is the persistence of practically acceptable performance and consequence structure across the materially relevant scales at which an intervention acts, propagates, redistributes burdens, or changes future capacity.

Relevant scales can include individual, household, organizational, institutional, sectoral, regional, national, transnational, ecological, or other domain-specific levels. The set should be determined by the practical problem rather than fixed in advance.

Cross-scale analysis should distinguish *scale propagation* from *scale transfer*. Propagation occurs when effects spread through connected levels. Transfer occurs when robustness at one level is achieved partly by moving risk, burden, maintenance cost, or fragility to another. An intervention can display local robustness and systemic fragility simultaneously.

Definition 11.177 (Robustness transfer). A *robustness transfer* occurs when improved stability, performance, or protection at one scale depends materially on increased exposure, fragility, burden, or reduced option space at another scale or

position.

The analysis should also attend to timescale. Fast operational robustness can consume slow institutional capacity. A crisis response can be effective over days while degrading trust, maintenance capability, or ecological conditions over years. Multi-scale robustness therefore includes temporal scale as well as organizational or spatial scale.

A *scale-robustness matrix* can record the relevant criteria, affected positions, propagation pathways, and transferred burdens at each scale. Such a matrix need not force the scales onto one metric. Its function is to prevent local stability from being mistaken for system-wide robustness.

Proposition 11.178 (Cross-scale robustness discipline). *A claim of practical robustness should specify the scale at which stability is observed and should examine whether that stability depends on burden transfer, hidden fragility, or capacity depletion at another materially connected scale.*

Scale analysis remains incomplete, however, when it compares only contemporaneous configurations. Robustness should also be examined across different historical trajectories.

11.9.9 Robustness across Historical Trajectories

Robustness across historical trajectories asks whether a practical commitment remains supportable when the system arrives at similar present configurations through different histories or when the same initial action unfolds through different path-dependent sequences. This is especially important in GR because subjects, institutions, capacities, and option spaces carry historical structure. Present similarity does not guarantee equivalent future response.

Definition 11.179 (Trajectory robustness). *Trajectory robustness* is the persistence of practical support across materially different historical pathways, including differences in event order, institutional formation, accumulated capacity, memory, trust, burden, and option structure.

Two organizations can have the same current resource level while differing sharply in institutional memory and repair capacity. Two communities can show similar aggregate outcomes while carrying different histories of exposure, recognition, or trust. Two technological systems can provide the same present function while differing in lock-in, maintenance dependence, or future interoperability. A robust decision method should therefore avoid treating current-state equivalence as historical equivalence.

Trajectory robustness also concerns the action itself. A strategy can perform acceptably when introduced early but poorly when introduced after a sequence of prior commitments. Order-sensitive transformations from Section 11.7 therefore enter robustness analysis directly. If $\Phi_b \circ \Phi_a$ and $\Phi_a \circ \Phi_b$ generate different fields, support for a cannot be evaluated independently of its placement within the history.

A useful object is a *trajectory-robustness profile*, recording how support changes across alternative path structures, event orders, inherited capacities, and prior institutional states. This profile should include future action-space consequences. An option can be robust in immediate performance while repeatedly creating lock-in, narrowing future alternatives, or concentrating control over subsequent decisions.

Definition 11.180 (Generative robustness). *Generative robustness* is the capacity of a practical pathway to remain acceptably functional across materially plausible histories while preserving or regenerating the capabilities, relations, institutional conditions, epistemic access, and action spaces required for future adaptation and responsible revision.

Generative robustness is therefore stronger than repeated short-run performance. It asks whether the decision leaves the practical field capable of learning, adapting, repairing, contesting, and generating later alternatives. A pathway can be robust in outputs yet generatively brittle if it depends on irreversible concentration, opaque infrastructure, depleted capability, or loss of future epistemic agency.

This concept also clarifies the relation between robustness and resilience. The present chapter does not require a universal definition of resilience. Where resilience is used in a domain-specific methodology, it can be located within the broader generative robustness profile according to the capacities for absorption, recovery, adaptation, transformation, and future option generation that the particular model represents.

The section can now be summarized through a layered practical question. The analyst first asks whether an action remains acceptable across specified histories and models. The analysis then asks whether that support survives representational differences, deep uncertainty, plural values, connected scales, and path-dependent historical structures. Finally, it asks whether the pathway preserves the capacity to revise itself when those conditions change.

Proposition 11.181 (Generative robustness principle). *For application-dominant praxis under materially open futures, robust practical support is strongest when a commitment remains acceptable across relevant histories and models while also preserving sufficient capacity for monitoring, learning, adaptation, repair, contestation, and future action-space revision.*

This final condition creates the transition to adaptive decision-making. Robust analysis identifies the regions in which a commitment can remain supportable despite variation; Section 292 develops the methods by which the commitment itself can change as epistemic events, monitoring, action-generated evidence, and field transformation alter those regions through time.

11.10 Adaptive Decision-Making in Evolving Fields

Section 11.9 developed robustness as persistence of practical support across materially relevant variation in histories, models, values, scales, and historical trajectories. The present section addresses the complementary methodological problem that arises when the practical field itself changes while a decision pathway is underway. Its role is to develop adaptive decision-making for situations in which epistemic events, observation, intervention, institutional response, actor learning, and generated consequences can alter the configuration being governed, the models used to represent it, the relative weights of admissible histories, and the action space available for later choice. The objective is to specify conditional decisions, update conditions, monitoring effects, model and history-weight revision, adaptive pathways, reversible commitment, escalation, de-escalation, action-space regeneration, and the co-evolution of decision rules with the fields in which they operate. The

method is intentionally plural: formal rules can be used where their semantics are justified, while qualitative, institutional, historical, and participatory updating remain equally available when the practical object cannot be adequately represented by one numerical state.

Adaptive decision-making in this framework is therefore more than repeated re-optimization. A decision procedure can alter after new observations, but the observation regime can also alter behavior; an intervention can reveal a mechanism while simultaneously changing that mechanism; a policy can generate new capacities or dependencies; and the decision rule itself can become part of the relational field that later actors learn, anticipate, resist, or exploit. Adaptation should consequently preserve a reconstructable distinction among changes in representation, changes in practical configuration, changes in the model family, changes in history weights, and changes in the decision rule.

Definition 11.182 (Adaptive decision architecture). *An adaptive decision architecture is a versioned arrangement of conditional commitments, observation and update rules, monitoring responsibilities, revision pathways, reversibility provisions, escalation and de-escalation conditions, and action-space regeneration mechanisms through which practical decisions can change as materially relevant epistemic or practical events transform the represented field.*

Table 11.10 summarizes the methodological architecture developed in this section.

11.10.1 Conditional Decisions

Adaptive decision-making begins by replacing unconditional one-shot commitment with explicit conditional structure where the practical situation supports it. A conditional decision specifies what commitment is authorized under a stated configuration, what observations or events matter for continuation, and what forms of revision become available when those conditions change. Conditionality can concern initiation, continuation, scale, duration, participation, resource release, monitoring intensity, or the depth of institutional change.

Definition 11.183 (Conditional practical decision). *A conditional practical decision is a commitment whose authorization, continuation, modification, escalation, suspension, reversal, or termination depends on explicitly stated practical conditions and on a specified procedure for determining whether those conditions obtain.*

A simple model-specific representation can map a decision-relevant interpreted configuration to a set of permissible commitments. Let Z_t denote the representation used by the decision procedure at stage t , and let $\mathcal{C}_t$ denote the currently admissible commitment forms. A conditional decision rule can be written as Equation 11.15.

$$\delta_t : Z_t \rightarrow \mathcal{C}_t. \quad (11.15)$$

Equation 11.15 is a schematic rule rather than a claim that practical judgment reduces to a mathematical function. The map can be partial because some represented situations may fall outside the rule's warranted domain. The codomain can also contain composite commitments such as "continue at present scale with intensified monitoring," "pause expansion and investigate a newly observed mechanism," or "activate a protected fallback pathway." Qualitative deliberation and institutional authorization can therefore remain part of the rule's implementation.

Table 11.10: Methodological architecture of adaptive decision-making in evolving fields.

Component	Primary function	Characteristic discipline
Conditional decisions	Link commitments to specified practical conditions	Preserve the conditions, authority, and revision logic of each commitment
Epistemic events	Trigger reassessment when knowledge or recognition changes	Distinguish readout, interpretation, and performative transformation
Monitoring effects	Observe trajectories while tracking observation-induced change	Treat monitoring regimes as potentially constitutive of the field
Model and history updating	Revise representations and relative support for histories	Preserve update semantics, provenance, and structural uncertainty
Adaptive pathways	Organize contingent sequences of practical commitments	Specify branches, gates, fallback routes, and learning opportunities
Reversible commitment	Preserve feasible correction under uncertainty	Maintain rollback capacity, memory, resources, and authority
Escalation	Increase commitment when stated conditions warrant deeper action	Separate evidence, consequence, capacity, and authorization conditions
De-escalation	Reduce exposure or commitment when continuation loses support	Preserve repair, transition, and learning rather than treating retreat as failure
Action-space regeneration	Create or restore later practical possibilities	Track capabilities, institutions, relations, and option-generating interventions
Rule-field co-evolution	Revise decision rules as their own effects accumulate	Version rules and monitor performative, strategic, and institutional feedback

The conditions attached to a decision should themselves be typed. An *epistemic condition* concerns what is sufficiently understood. A *consequence condition* concerns observed or anticipated effects. A *capacity condition* concerns whether implementation, monitoring, repair, or reversal remains feasible. An *institutional condition* concerns mandate, authority, coordination, or accountability. A *justice condition* concerns burdens, benefits, risk, recognition, participation, or generative opportunity. A *temporal condition* concerns windows within which a commitment remains meaningful or reversible.

Definition 11.184 (Decision-condition profile). A *decision-condition profile* records the conditions that govern initiation, continuation, modification, escalation, de-escalation, suspension, reversal, or reopening of a practical commitment, together with the observation regime, responsible positions, and authority through which each condition is interpreted.

Conditional decisions should avoid pseudo-precision. A condition such as “continue if performance remains acceptable” is operationally weak unless the relevant performance dimensions, affected positions, uncertainty, and authority of interpreta-

tion are specified. Conversely, overly rigid numerical conditions can become brittle where measurement is noisy, performative, delayed, or incomplete. The appropriate form of conditionality depends on the practical object.

Conditional architecture also has distributive consequences. Actors with authority to interpret whether a condition has been met can acquire substantial practical power. An adaptive method should therefore record who defines the indicators, who observes them, whose testimony can trigger review, who can challenge the interpretation, and who bears the consequences of false continuation or false suspension.

The value of conditionality lies partly in its capacity to separate stages of commitment. A practical system can authorize an initial action while withholding deeper commitment until specified learning, capacity, safety, or participation conditions are met. This converts some uncertainty into a structured sequence rather than requiring either complete prior knowledge or unconditional action.

11.10.2 Epistemic Events as Update Conditions

Section 11.4 distinguished observation as readout from epistemic events that can acquire performative consequences through interpretation, communication, recognition, classification, or institutional uptake. Adaptive decision-making uses epistemic events as possible update conditions while retaining that distinction. A new measurement, testimony, anomaly, model comparison, classification change, or machine-generated pattern can justify revision of a decision rule, yet the event can also change the practical field once actors respond to it.

Definition 11.185 (Adaptive update condition). An *adaptive update condition* is an epistemic or practical event whose occurrence is specified as materially relevant to the continuation, revision, escalation, de-escalation, suspension, or reopening of a decision pathway.

Not every new observation should trigger revision. Continuous adaptation to weak signals can produce instability, strategic manipulation, or excessive administrative burden. Update conditions should therefore be connected to the practical significance of the event, the reliability of the observation regime, the depth of current commitment, and the cost of both delayed and premature revision.

Epistemic events can operate at several levels. A *parameter-level event* changes an estimate within an otherwise stable representation. A *structural event* challenges the relations or mechanisms represented by the model. A *boundary event* reveals an affected subject, relation, scale, or consequence that had been omitted. A *normative event* changes the practical interpretation of values, responsibilities, or protected conditions. A *generative event* creates a new capacity, institution, relation, or action that changes the space of possible decisions.

An adaptive rule should record which level is implicated. Updating a parameter when the event actually challenges the model structure can create false continuity. Replacing the entire model after an ordinary parameter fluctuation can create unnecessary instability. The response should be proportionate to the type and practical significance of the epistemic event.

The event can also change the interpretation of earlier evidence. A newly identified mechanism may make an old observation newly relevant. Later testimony can reveal that an earlier aggregate indicator concealed concentrated harm. A new insti-

tutional category can reorganize historical records. Adaptive updating can therefore include *retrospective re-epistemization*, while preserving the as-of state that originally informed the decision.

Proposition 11.186 (Typed-update discipline). *When an epistemic event materially affects an adaptive decision pathway, the revision should distinguish whether the event changes a parameter, model structure, practical boundary, normative interpretation, generative condition, or some combination of these, because different update types warrant different practical responses.*

Epistemic events are often detected through monitoring. Monitoring, however, is itself part of the practical architecture and can alter the field it observes.

11.10.3 Monitoring and Observation Effects

Monitoring supports adaptation by producing repeated observations of implementation, consequences, capacities, risks, institutional response, and changes in the practical field. Yet monitoring should not be treated as an invisible window onto an unchanged system. Measurement can redirect attention, alter incentives, change reporting behavior, stabilize categories, create surveillance burdens, or influence the expectations of actors who know they are being observed.

Definition 11.187 (Monitoring regime). A *monitoring regime* is the organized arrangement of observations, indicators, reporting relations, interpretive procedures, responsibilities, temporal cadence, and revision pathways through which an adaptive decision process follows the evolution of a practical field.

The monitoring regime should identify both the *observation object* and the *observation effect*. The observation object is what the method seeks to learn about. The observation effect is the change generated because measurement, reporting, inspection, participation, publication, or classification occurred. The two can coexist. A monitoring system can reveal a deterioration in service quality while the publication of that indicator simultaneously changes staff behavior and organizational priorities.

A useful methodological record is an *observation-effect profile*, which asks whether the monitoring regime changes incentives, trust, disclosure, participation, strategic behavior, resource allocation, or the categories through which the practical problem is understood. These effects may be beneficial, harmful, or mixed. Their presence does not invalidate monitoring; it makes performativity part of the method's consequence structure.

Monitoring also has a temporal architecture. High-frequency observation can detect rapid instability but can amplify noise and encourage short-horizon reaction. Low-frequency observation can preserve stability but miss fast deterioration or narrow windows for reversible intervention. Different variables can therefore require different cadences. Fast operational signals and slow institutional, ecological, relational, or capability indicators may need to coexist.

Adaptive monitoring should preserve epistemic pluralism. Quantitative indicators can be combined with qualitative observation, historical comparison, front-line reports, affected-subject testimony, expert judgment, and machine-assisted pattern detection. Their disagreement can itself be an update condition. A stable aggregate metric alongside persistent localized testimony, for example, can indicate a boundary problem, distributional masking, or measurement failure.

Monitoring burden also matters. Repeated reporting can consume scarce capacity, privilege actors able to produce standardized data, or shift labor toward what is measurable. An adaptive system that exhausts the institution it monitors can become self-defeating. Monitoring intensity should therefore remain proportionate to decision relevance, risk, reversibility, uncertainty, and available capacity.

The dedicated monitoring methodology developed later in Section 303 will examine indicator design, observational infrastructures, and monitoring governance in greater detail. The present section establishes the narrower adaptive point: monitoring both informs and participates in the evolution of the decision field.

11.10.4 Updating of Models and History Weights

Adaptive decision-making requires a disciplined account of what changes when new evidence arrives. Some events support parameter updating within an existing model. Others justify revision of model structure, replacement of a model family, modification of the represented history space, or reweighting of admissible histories. These operations should remain distinct enough that later users can reconstruct why the decision pathway changed.

Let $\mathcal{M}_t$ denote the active model family at stage t , and let W_t denote whatever model-specific history-weight structure is being used where such a structure is justified. An epistemic update can be represented schematically by Equation 11.16.

$$(\mathcal{M}_{t+1}, W_{t+1}) = \mathcal{U}_t^{\text{ep}}(\mathcal{M}_t, W_t; e_t, x_t, \rho_t), \quad (11.16)$$

where e_t denotes the epistemic event, x_t the associated readout or representation where applicable, and ρ_t a record of the assumptions, provenance, and practical context used in the update. Equation 11.16 deliberately leaves the update operator open. Depending on the model, it can represent Bayesian conditioning, parameter estimation, qualitative reinterpretation, likelihood-free reweighting, model comparison, structural revision, replacement of a causal account, or another explicitly defined procedure.

The semantics of W_t remain model-specific. Where W_t is a probability distribution, normalization and probabilistic updating may be appropriate. Where it represents accessibility, plausibility, transition propensity, simulation mass, or another nonnegative quantity, probability language should not be imported automatically. Where no coherent weighting semantics exist, the adaptive method can revise scenario families qualitatively without inventing numerical weights.

A second distinction concerns *reweighting* and *history-space transformation*. An update can change the relative support attached to already represented histories. It can also create a new branch, remove an obsolete branch, reveal a previously omitted subject, or alter the generative rule through which future histories are constructed. In the latter case, the history space itself changes.

Definition 11.188 (Adaptive model revision record). An *adaptive model revision record* documents the epistemic event or practical consequence that triggered revision, the prior model and history representation, the update operation, changes in parameters or structure, changes in history weights or admissible histories, remaining model disagreement, and the resulting implications for practical commitment.

Model plurality should remain visible through updating. If several model families

interpret the same epistemic event differently, adaptation can preserve the disagreement rather than forcing immediate convergence. The decision may remain robust across the models, become conditional on one interpretation, or require deeper inquiry before commitment is increased.

The possibility of amplitude-like history models remains open under the stronger assumptions specified in Section 11.8. Adaptive updating in such a model would require semantics for the update of amplitudes, phase relations, composition, and observation. The present general method therefore continues to use nonnegative history weights and transition potentials as the more permissive vocabulary where weighting is needed.

11.10.5 Adaptive Pathways

An adaptive pathway organizes conditional decisions through time. It specifies an initial commitment, anticipated observation points, branch conditions, possible expansions or contractions, fallback routes, and the practical conditions under which the pathway should be reconsidered. The pathway is therefore neither a fixed plan nor a sequence improvised without memory. It is a versioned structure for continuing commitment.

Definition 11.189 (Adaptive pathway). An *adaptive pathway* is a temporally and relationally ordered family of practical commitments connected by explicit branch, review, escalation, de-escalation, suspension, reversal, or regeneration conditions that can be revised as the represented field changes.

Adaptive pathways can take several forms. A staged pathway can move from reversible trial to limited deployment and then to broader commitment. A branching pathway can select different responses according to future conditions. A portfolio pathway can maintain several parallel options until uncertainty narrows. A protective pathway can authorize temporary safeguards while a deeper diagnosis proceeds. A recovery pathway can prioritize stabilization, repair, and later institutional redesign.

The pathway should record *branch provenance*. A branch should exist for an identifiable practical reason: a model uncertainty, safety concern, institutional dependency, distributional risk, learning opportunity, or value conflict. Excessive branching can make the pathway administratively unusable, while insufficient branching can hide materially different future conditions under one rule.

Adaptive pathways also have generative effects. An early stage can build capability, create trust, generate institutional memory, or develop new monitoring infrastructure. These effects can make later actions reachable. Conversely, an early commitment can create lock-in, exhaust capacity, or change expectations in ways that close later branches. Pathway design should therefore evaluate the action-space consequences of each stage as part of the decision itself.

A useful methodological object is a *pathway state record*, which at each review point preserves the current practical configuration, active branch, observed consequences, unresolved uncertainties, model versions, available actions, responsible positions, and next review conditions. This prevents adaptive decision-making from becoming a sequence of disconnected reactions whose original rationale cannot later be reconstructed.

Proposition 11.190 (Adaptive-pathway discipline). *An adaptive pathway is methodologically stronger when each major transition preserves a traceable relation among the triggering condition, the evidence and model state, the authority for revision, the action-space consequence, and the residual uncertainty carried forward.*

One important design property of an adaptive pathway is the preservation of reversible commitment.

11.10.6 Reversible Commitment

Reversible commitment permits action under incomplete knowledge while preserving feasible pathways for correction. The concept extends the practical reversibility developed in Chapter 10 into a methodological design principle. Reversibility requires more than a statement that a decision can later be changed. It requires sufficient material, institutional, informational, legal, and relational capacity to make reversal, repair, or redirection practically reachable.

Definition 11.191 (Reversible commitment architecture). *A reversible commitment architecture is the set of design provisions that preserve a practically usable pathway for suspending, redirecting, rolling back, repairing, or replacing a commitment within the relevant horizon and with burdens judged acceptable for the affected positions.*

A reversible architecture can include modular implementation, temporary authorization, staged resource release, preserved alternatives, data portability, contractual exit clauses, institutional redundancy, fallback infrastructure, reserve capacity, repair funds, documentation, and protected authority to trigger rollback. Which elements matter depends on the domain.

Reversibility is also positional. An institution may be able to terminate a programme while affected subjects remain unable to restore lost housing, employment, trust, health, status, ecological conditions, or institutional standing. The method should therefore evaluate reversal across materially relevant positions rather than from the perspective of the formal decision-maker alone.

The architecture should also recognize *reversibility decay*. A commitment that is easy to reverse during an early stage can become difficult to undo after complementary investments, institutional adaptation, expectation formation, dependency, or loss of alternative capacity. Review intervals should therefore be related to the rate at which rollback capacity is expected to decline.

A useful concept is a *reversibility reserve*: the resources, authority, institutional memory, technical capacity, relational access, and practical options retained specifically to support later correction. Using that reserve for immediate performance can increase short-run efficiency while making adaptation more brittle. The trade-off should remain visible.

Reversible commitment is valuable partly because it can create learning while limiting exposure. Yet reversibility should not be used to justify careless experimentation. A formally reversible pilot can still impose concentrated burdens, alter trust, generate stigma, or create hard-to-repair relational effects. Reversibility modifies the commitment profile; it does not cancel the requirements of justice, participation, or responsibility.

11.10.7 Escalation

Escalation increases the depth, scale, duration, resource commitment, institutional reach, or irreversibility of a practical pathway. In an adaptive architecture, escalation should occur through explicit conditions rather than by inertia. Early implementation success can create political, organizational, or psychological momentum that makes expansion appear self-justifying. The method should preserve the distinction between evidence that the current stage is functioning and evidence sufficient for a deeper stage.

Definition 11.192 (Adaptive escalation). *Adaptive escalation* is an authorized increase in the depth, scale, duration, resource commitment, institutional reach, or practical irreversibility of a pathway following review of the conditions relevant to that increase.

Escalation conditions can include several dimensions. An *epistemic condition* concerns whether the mechanism and consequence structure are sufficiently understood for deeper commitment. A *performance condition* concerns whether relevant goals and criteria are being met. A *capacity condition* concerns whether the implementing system can absorb expansion without degrading quality, monitoring, repair, or accountability. A *distributional condition* concerns whether benefits, burdens, and risks remain acceptable across affected positions. A *reversibility condition* concerns whether deeper commitment would create material option loss. An *authorization condition* concerns whether the institution has legitimate authority for the expanded action.

An *escalation gate* records these requirements and the evidence used to interpret them. The gate can be conjunctive, partially ordered, or deliberative. It does not need to collapse all conditions into a scalar score. Some protected conditions may function as noncompensatory constraints.

Escalation can also be asymmetric. Increasing scale can be easy while later reduction is politically or technically difficult. Increasing data collection can create infrastructures that persist after the original purpose ends. Expanding an institution's authority can change expectations and power relations even if the formal authorization remains temporary. The escalation review should therefore examine future de-escalation and exit at the moment deeper commitment is considered.

Proposition 11.193 (Escalation burden principle). *As a practical pathway increases exposure, duration, scale, irreversibility, option foreclosure, or institutional concentration, the methodological burden ordinarily shifts toward broader evidence, stronger consequence tracking, clearer responsibility, and more explicit justification of the remaining revision and exit pathways, subject to the urgency and consequence structure of the situation.*

Proposition 11.193 is deliberately scoped. Urgent protective action can justify rapid escalation under severe threat even when evidence remains incomplete. The deeper commitment should then carry intensified monitoring, review, and de-escalation provisions appropriate to that uncertainty.

11.10.8 De-Escalation

De-escalation reduces the depth, scale, duration, exposure, or institutional commitment of a practical pathway. It is an affirmative adaptive operation rather than sim-

ply a failure to continue. A pathway can require de-escalation because the intervention no longer produces sufficient benefit, because harms or inequities have emerged, because institutional capacity is being depleted, because a new model changes the expected history structure, because the problem itself has changed, or because a temporary protective measure has served its purpose.

Definition 11.194 (Adaptive de-escalation). *Adaptive de-escalation* is an authorized reduction, narrowing, suspension, transition, or staged withdrawal of practical commitment in response to materially relevant changes in evidence, consequences, capacity, values, authority, risk, or the practical field.

De-escalation requires design. Abrupt withdrawal can transfer burden to actors who adapted to the intervention, destroy useful capacity, or create a vacuum in maintenance and responsibility. A de-escalation pathway should therefore specify transition duties, preserved functions, repair, communication, reassignment of responsibility, and continued monitoring where delayed consequences remain possible.

The method should distinguish several forms. *Scope de-escalation* narrows the population, domain, or mechanism addressed. *Intensity de-escalation* reduces resource use or intervention strength. *Temporal de-escalation* shortens duration or reduces frequency. *Institutional de-escalation* returns authority or responsibilities to other positions. *Epistemic de-escalation* reduces reliance on a model, indicator, or automated system whose warrant has weakened.

De-escalation can also preserve learning. A programme that contracts after detecting a failure mode can retain records, infrastructure, and experimental knowledge for later redesign. Treating de-escalation as institutional embarrassment can create incentives to conceal adverse evidence. Treating it as an expected part of adaptive governance can improve epistemic honesty and reduce lock-in.

A useful methodological object is a *de-escalation transition record*, documenting the trigger, affected functions, responsibilities transferred or retained, repair obligations, residual consequences, preserved knowledge, and conditions under which a redesigned pathway could later be reconsidered.

Escalation and de-escalation together prevent adaptation from being equated with unidirectional growth. A mature adaptive system can deepen, narrow, pause, redirect, or terminate commitments according to the evolving field.

11.10.9 Action-Space Regeneration

Adaptive decision-making is incomplete when it only chooses among currently reachable actions. Sections 11.7 and 11.8 showed that histories can generate and foreclose options. The present subsection turns that observation into an explicit methodological objective: when the current action space is inadequate, adaptation can seek to create, restore, or recombine practical possibilities.

Definition 11.195 (Action-space regeneration). *Action-space regeneration* is the deliberate creation, restoration, recombination, or reactivation of practical capacities, relations, institutions, knowledge, authority, infrastructures, or coordination pathways that make later actions newly reachable or recover previously foreclosed possibilities.

Regeneration can occur through capability development, institutional redesign, trust repair, new coordination mechanisms, resource mobilization, legal authoriza-

tion, technological change, knowledge production, translation, conflict transformation, or restoration of damaged infrastructure. The relevant mechanism should be specified rather than described only as “expanding options.”

Action-space regeneration is especially important when the satisficing region from Section 11.9 is empty or when every currently reachable option violates an important protected condition. The adaptive problem then shifts from selecting an existing action to transforming the field so that a better action becomes possible.

A model-specific update of the effective action space can be represented as Equation 11.17.

$$\mathcal{A}_{t+1}^{\text{reach}} = \mathcal{G}_t(\mathcal{A}_t^{\text{reach}}, \omega_t, e_t, a_t, \Delta \mathbf{S}_t, \Delta \mathcal{I}_t, \Delta \mathbf{K}_t), \quad (11.17)$$

where $\Delta \mathbf{S}_t$ denotes changes in relevant subjects or relational positions, $\Delta \mathcal{I}_t$ institutional change, and $\Delta \mathbf{K}_t$ changes in practical capacities or knowledge. Equation 11.17 extends the recursive action-space architecture of Section 11.7 by emphasizing the deliberate regeneration of reachability.

Regeneration should remain normatively assessed. Generating new power, information, surveillance capacity, coercive authority, or technical capability can create harmful actions as well as beneficial ones. The methodological question is therefore which possibilities are generated, for whom, under whose control, with what dependence, and with what consequences for later agency and justice.

A useful *regeneration profile* records the option-generating mechanism, beneficiaries, newly capable actors, dependencies, required maintenance, possible harmful capabilities, and the durability of the resulting action space. This makes option generation itself an evaluable intervention rather than an unexamined good.

Action-space regeneration also links adaptation to research. If the barrier is epistemic, new inquiry can generate a practical option. If the barrier is institutional, organizational redesign can create new authority or coordination. If the barrier is relational, participation or trust repair can make cooperation possible. Adaptive methodology should therefore identify what kind of generative transformation is required before assuming that more analysis of the existing menu will improve the decision.

11.10.10 Co-Evolution of Decision Rule and Field

The preceding subsections imply that an adaptive decision rule cannot always be treated as external to the field it governs. Conditional rules shape expectations. Monitoring changes behavior. Escalation and de-escalation alter institutions. Repeated criteria can stabilize categories. Automated rules can invite strategic response. Action-space regeneration changes who can act. Over time, the decision rule and the practical field can therefore co-evolve.

Definition 11.196 (Rule-field co-evolution). *Rule-field co-evolution* is the reciprocal historical process through which decision rules influence the practical configuration and the resulting changes in actors, relations, institutions, observations, capacities, and histories subsequently alter the appropriateness, interpretation, or structure of those rules.

A schematic representation can separate the field update from the rule update. Let ω_t denote the practical configuration and δ_t the operative decision rule. Their coupled

evolution can be represented as Equation 11.18.

$$\begin{aligned}\omega_{t+1} &= \Phi_t(\omega_t; a_t, e_t, \delta_t), \\ \delta_{t+1} &= \mathcal{V}_t(\delta_t; \omega_{t+1}, e_t, \mathcal{M}_{t+1}, W_{t+1}).\end{aligned}\tag{11.18}$$

Equation 11.18 is a modeling template. The first line represents transformation of the practical field under action, epistemic events, and the institutional consequences of the rule itself. The second represents revision of the decision rule in response to the changed field and updated epistemic architecture. The functions Φ_t and $\mathcal{V}_t$ need not be numerical and need not remain fixed through time.

This co-evolution creates several methodological risks. A rule can become self-validating if it determines what gets measured and then treats those measurements as evidence of its success. Actors can learn to optimize against the rule, changing the relationship between indicator and underlying practical condition. An institution can develop capabilities specialized to one decision architecture and thereby make alternatives harder to implement. Temporary categories can become durable identities or administrative boundaries. Adaptive governance should therefore monitor the consequences of the rule itself.

Definition 11.197 (Decision-rule provenance). *Decision-rule provenance* is the record of how a practical decision rule was formed, the evidence and models on which it depended, the conditions under which it was authorized, its successive revisions, the field changes associated with its operation, and the reasons for maintaining, replacing, or retiring it.

Versioning is central to this provenance. A rule that has changed repeatedly should not be treated as though it were one timeless method. Each version can carry a different action space, criterion architecture, model family, authority structure, and consequence profile. Versioned records permit later evaluation to distinguish failure of an original design from failure introduced through cumulative adaptation.

Co-evolution also means that successful adaptation can eventually make its original rule unnecessary. A temporary coordination mechanism can build durable institutional capacity. A safety intervention can transform conditions so that the original trigger rarely occurs. A participatory process can generate collective agency that supports a different governance architecture. Adaptive methodology should allow retirement or transformation of its own decision rule when the field it helped create no longer warrants the original structure.

Proposition 11.198 (Adaptive co-evolution principle). *In evolving practical fields, adaptive decision-making is strongest when it treats decision rules, observation regimes, models, action spaces, and institutional capacities as historically revisable components whose own effects can become objects of monitoring, evaluation, and redesign.*

The architecture developed in this section extends robust decision-making from comparative stability to governed change. Conditional decisions specify how commitment depends on the field; epistemic events and monitoring create update conditions; model and history structures remain revisable; adaptive pathways preserve staged alternatives; reversible commitments retain correction capacity; escalation and de-escalation govern changes in depth; action-space regeneration creates later possibilities; and rule-field co-evolution makes the decision procedure itself part of the object of inquiry. Section 293 turns next to optimization and its limits, examining where optimization can serve this broader adaptive architecture and where its

assumptions become too restrictive for historically evolving, heterogeneous, and partially incommensurable practical fields.

11.11 Decision-Making under Critical-Transition Uncertainty

The role of this section is to develop a decision architecture for practical fields in which qualitative transition is a plausible possibility and the system's location relative to such a transition remains uncertain. Its objective is meta-methodological: it does not assume that every social, institutional, ecological, technological, or economic field is near criticality, and it does not treat criticality as an ontological diagnosis available directly from observation. The section instead asks how decision discipline should change when one or more defensible models admit regime change, bifurcation, tipping behavior, abrupt reorganization, strong path dependence, or comparable transition structures within the practical horizon. The discussion proceeds through criticality as a model-relative hypothesis, regime uncertainty, response sensitivity, diagnostic evidence, intervention-induced transition, hysteresis and path dependence, staged commitment, multiscale monitoring, model plurality, and transition-sensitive decision discipline. The method combines dynamical-systems reasoning with the historically relational and epistemically plural architecture developed earlier in the chapter.

Dynamical-systems theory provides several formal languages for qualitative changes in system behavior, including bifurcation and changes in stability structure (Kuznetsov 2023; Strogatz 2024). Research on critical transitions also shows that some systems can exhibit conditional early-warning patterns before certain threshold changes, while the interpretation and reliability of such indicators remain model- and context-dependent (Scheffer et al. 2009). These literatures motivate a practical distinction between ordinary uncertainty within a relatively stable regime and uncertainty about whether the regime itself can change. The present section uses that distinction as an analytical resource under the book's ontological-suspension commitment.

Definition 11.199 (Critical-transition decision context). A *critical-transition decision context* is a practical situation in which one or more defensible representations admit a nearby or decision-relevant qualitative change in the system's dynamical, institutional, relational, or generative regime, while the location, mechanism, timing, or even existence of that transition remains uncertain enough to affect practical judgment.

The definition deliberately includes uncertainty about the criticality hypothesis itself. A field can display volatility, delay, polarization, rapid technological change, institutional stress, or nonlinear response without satisfying the assumptions of a particular critical-transition model. Decision methodology should therefore preserve the difference between observing unusual change and establishing that a formal criticality model applies.

Table 11.11 summarizes the main practical qualifications developed in this section.

The rows in Table 11.11 are qualifications rather than universal prescriptions. Some critical-transition models support precise quantitative analysis; other practical fields justify only a qualitative hypothesis that the response structure may be changing. The common methodological requirement is to avoid silently extend-

Table 11.11: Decision qualifications under critical-transition uncertainty.

Analytical issue	Ordinary local assumption	Critical-transition concern	Practical qualification
Response structure	Marginal response remains locally transportable	Response can change sharply across regimes	Preserve model plurality and local validity domains
Historical trajectories	Nearby starting points yield comparable histories	Small differences can enter qualitatively different histories	Examine branching, basin change, and path dependence
Evidence transport	Recent evidence remains informative for the next stage	Data can straddle or precede a regime change	Time-stamp evidence and reopen transport assumptions
Intervention effect	Action perturbs a stable field	Action can contribute to crossing a transition boundary	Stage commitment and monitor transition-sensitive signals
Reversibility	Removing an intervention approximately restores prior conditions	Hysteresis or generated structure can obstruct return	Preserve options, repair capacity, and post-transition monitoring
Monitoring	Stable indicators provide sufficient feedback	Aggregate or delayed indicators can miss local reorganization	Use multiscale, heterogeneous, and mechanism-sensitive monitoring
Decision rule	One calibrated rule remains applicable	Rule performance can be regime-dependent	Pre-specify revision and reauthorization conditions

ing stable-regime inference into a region where the representation itself suggests possible structural change.

11.11.1 Criticality as a Model-Relative Practical Hypothesis

Criticality enters application-dominant praxis through a model or family of models. A dynamical representation can contain an equilibrium that loses stability, a basin boundary that moves, a threshold beyond which another attractor becomes accessible, or a parameter region in which response becomes highly sensitive. An institutional or historical analysis can identify analogous reorganization without claiming mathematical identity with a physical phase transition. The methodological status of these representations should remain explicit.

Definition 11.200 (Criticality hypothesis). A *criticality hypothesis* is a scoped and revisable claim that the practical field may be located in a region where one or more represented transition mechanisms can produce a qualitative change in trajectories, stability, relational organization, or reachable future configurations.

The hypothesis has at least four components: a represented field or subsystem, a proposed transition mechanism, an evidential basis for locating the field relative to the transition, and a statement of practical consequences if the hypothesis is wrong or incomplete. Different models can propose different order parameters, boundaries, or transition mechanisms. A decision architecture should preserve those differences when they materially affect action.

This model-relative treatment avoids two opposite errors. One error is to dismiss nonlinear or transition-sensitive dynamics because the system cannot be described with the precision of a laboratory model. The other is to label any rapid or surprising change as criticality. The middle position treats criticality as a hypothesis whose practical relevance depends on whether it changes what should be monitored, compared, staged, protected, or kept reversible.

11.11.2 Regime Uncertainty and Local Model Fragility

Many decision methods rely on local regularity. Recent observations are used to estimate response; causal relations are transported over a short horizon; marginal effects are extrapolated; or parameters are assumed to vary smoothly. These methods can remain useful near a transition, but their validity domain can become narrower when the system's governing relationships are changing.

Definition 11.201 (Regime uncertainty). *Regime uncertainty* is uncertainty concerning which qualitative response structure, stability pattern, institutional configuration, or generative mechanism currently governs the practical field and how that governing structure can change within the decision horizon.

Regime uncertainty differs from parameter uncertainty inside one fixed model. A confidence interval around a parameter does not automatically represent uncertainty about whether the model family remains appropriate after a qualitative transition. A decision process can therefore require both parameter uncertainty and model-structure uncertainty.

Local model fragility should be interpreted proportionately. A model can remain useful for short-horizon monitoring even when its long-horizon extrapolation becomes unreliable. A causal mechanism can remain valid for one subpopulation while the aggregate field reorganizes. A stable local control rule can remain safe within a bounded region. The practical question concerns the domain in which the model continues to carry enough of the field for the intended commitment.

11.11.3 Sensitivity, Amplification, and Divergent Histories

Critical-transition uncertainty increases the importance of history-space analysis. Near some represented boundaries, small differences in initial configuration, parameter path, event order, or intervention timing can contribute to markedly different later histories. The relevant decision problem can therefore concern the distribution of reachable regimes and the preservation of future options as much as the optimization of an expected local outcome.

The word *sensitivity* has several meanings and should be disambiguated. Numerical sensitivity concerns changes in model output under perturbed input. Dynamical sensitivity concerns divergence of trajectories under the model's evolution. Institutional sensitivity can concern whether a small procedural change activates a qualita-

tively different rule. Relational sensitivity can concern whether a change in one tie or position reorganizes a larger network. A practical analysis should state which sense is relevant.

Scenario families from Section 11.8 become especially important here. Reference histories can be supplemented with transition histories, failed-transition histories, delayed transitions, overshoot paths, recovery paths, and histories in which the criticality hypothesis proves inapplicable. Robustness analysis from Section 11.9 can then ask which commitments remain acceptable across these qualitatively different possibilities.

11.11.4 Diagnostic Evidence and Early-Warning Interpretation

Some dynamical models admit observable patterns that can precede particular critical transitions. The literature on early-warning signals discusses phenomena such as slower recovery from perturbation and changes in autocorrelation or variance under specified conditions (Scheffer et al. 2009). These signals can be useful, yet they are conditional on the underlying transition mechanism, observation process, sampling design, noise structure, and scale.

A meta-framework should therefore avoid treating one indicator as a universal criticality detector. The practical use of an early-warning measure should identify the model that gives the signal meaning, the observational regime that produces it, the alternative mechanisms that can produce similar patterns, and the consequence of false positive or false negative interpretation.

Definition 11.202 (Transition-diagnostic profile). A *transition-diagnostic profile* records the hypothesized transition mechanism, selected indicators, observational scale, expected signal structure, alternative explanations, uncertainty, and practical decisions that would be affected by interpreting the field as approaching a qualitative transition.

Historical and interpretive evidence can complement formal indicators. Institutional weakening, changing coordination conventions, rapid category redefinition, loss of redundancy, or altered legitimacy can be transition-relevant without possessing a justified scalar early-warning index. The chapter's methodological pluralism therefore applies to criticality diagnosis as well as to ordinary decision analysis.

11.11.5 Intervention-Induced Transition Risk

An intervention can alter the system's location relative to a transition. A policy can change incentives, a classification can reorganize access, an infrastructure can create network dependence, a technological deployment can accelerate adaptation, or a resource shift can weaken a stabilizing buffer. Decision analysis near criticality should therefore represent the intervention as one of the forces potentially changing regime structure.

Definition 11.203 (Transition-coupled intervention). A *transition-coupled intervention* is an intervention whose modeled or plausibly interpreted effects can materially alter the accessibility, timing, mechanism, or consequence of a qualitative transition in the practical field.

The definition includes interventions intended to prevent or induce transition.

Stabilization, transformation, resilience building, institutional reform, and managed phase-out can each interact with transition structure. The key methodological task is to make the coupling explicit enough that the intervention is not evaluated only through within-regime effects.

Intervention-induced transition also complicates causal evaluation. If the intervention changes the response regime, the post-intervention relation between inputs and outcomes can differ from the relation used to justify the action. Evaluation should then include whether the intervention changed the model class or validity domain, not only whether a predicted outcome occurred.

11.11.6 Reversibility, Hysteresis, and Historical Dependence

A practical transition can be historically asymmetric. Some dynamical systems exhibit hysteresis, so reversing the parameter that contributed to a transition does not necessarily restore the previous state along the same path. Institutional and relational fields can also generate durable structures, expectations, sunk investments, classifications, dependencies, or lost capabilities that persist after an intervention is withdrawn. These mechanisms should be analyzed on their own terms even when a formal hysteresis model is unavailable.

The implication for decision methodology is that rollback and restoration are separate questions. Section 11.25 develops exit and rollback generally. Under critical-transition uncertainty, the design should also ask whether crossing a plausible transition changes the cost, feasibility, or meaning of return.

Definition 11.204 (Transition-reversibility profile). A *transition-reversibility profile* records the represented pathways of return after a qualitative change, the resources and capacities required for those pathways, the historical residues expected to persist, and the uncertainty concerning whether restoration remains reachable.

This profile can motivate preservation of redundancy, institutional memory, fallback infrastructure, or repair capacity before a transition occurs. These devices do not guarantee reversibility. They preserve practical possibility where the field permits it.

11.11.7 Staged Commitment and Option Preservation

Critical-transition uncertainty can increase the value of staged commitment when delay remains practically tolerable. A staged intervention can create information before later commitment, distribute exposure, test mechanism, or preserve alternative pathways. This logic connects directly to adaptive decision-making in Section 11.10 and experimental intervention in Section 11.20.

Staging should not be treated as universally conservative. In some fields, slow action increases the probability of an undesirable transition or closes a temporary window for beneficial transformation. The practical comparison is therefore among histories generated by different commitment schedules, including the history generated by delay.

Definition 11.205 (Transition-sensitive option profile). A *transition-sensitive option profile* records which future actions remain accessible, become newly accessible, become more costly, or become foreclosed under alternative commitment paths and

plausible transition histories.

Option preservation can concern material reserves, institutional flexibility, legal authority, ecological buffers, technical interoperability, social trust, learning capacity, or other locally relevant resources. It should be represented at the scale at which the future option actually exists.

11.11.8 Multiscale Monitoring and Transition Detection

Qualitative change can appear differently across scales. A local subsystem can reorganize while aggregate indicators remain stable; an aggregate shift can emerge from many heterogeneous local changes; and leading signals at one temporal scale can be masked by faster noise or slower structural trends. Monitoring near criticality should therefore consider whether the selected resolution can observe the transition mechanism being hypothesized.

Multiscale monitoring can combine aggregate indicators, local relational measures, institutional events, qualitative reports, dynamical indicators, and mechanism-specific observations. More data is not automatically better. The monitoring architecture should select signals according to their relation to the criticality hypothesis and the practical consequences of missing a change.

Observation can also become performative. Public warning indicators can change behavior, institutional response, or expectations. The signal can therefore help prevent, delay, or accelerate the transition it was intended to detect. Section 11.4 provides the general epistemic architecture for interpreting such recursive evidence.

11.11.9 Model Plurality and Transition Disagreement

Different models can disagree about whether a transition exists, which variables organize it, where the boundary lies, and which intervention moves the system toward or away from it. This disagreement should remain visible when it changes practical conclusions. Averaging incompatible transition mechanisms into one forecast can obscure the reason the models disagree.

A useful decision record can separate at least three cases. In the first, several models support similar practical precautions despite differing mechanisms. In the second, models recommend different monitoring but similar immediate action. In the third, the practical commitment changes sharply with the selected model. The third case creates a stronger need for robustness analysis, staged action, or additional inquiry.

Definition 11.206 (Transition-model disagreement profile). A *transition-model disagreement profile* records the alternative transition mechanisms, validity domains, evidential supports, practical recommendations, and decision-sensitive disagreements among the model families considered relevant to the field.

Historical interpretation can belong in this profile. A model that captures short-run dynamics can coexist with an institutional history suggesting that the key transition variable is being misidentified. The practical architecture should preserve such remainders until evidence justifies stronger synthesis.

11.11.10 Transition-Sensitive Decision Discipline

Decision-making under critical-transition uncertainty requires a change in methodological emphasis. Local prediction remains useful, but practical judgment also attends to model validity domains, branching histories, regime-sensitive evidence, option preservation, intervention-induced transition, reversibility, and model disagreement. These concerns are additions to the ordinary decision architecture, not replacements for it.

Proposition 11.207 (Transition-sensitive decision discipline). *When a defensible criticality hypothesis is materially relevant to a contemplated commitment, decision methodology should make the hypothesis, model dependence, transition-sensitive evidence, plausible regime alternatives, intervention coupling, reversibility, and reopening conditions visible at a depth proportionate to the consequences of transition and the costs of delay.*

Proposition 11.207 leaves several legitimate practical responses open. A field can justify immediate transformation, stabilization, staged experimentation, option preservation, intensified monitoring, additional research, or continued ordinary operation when the criticality hypothesis is weak. The framework does not select among these responses independently of the local history and evaluative frame.

This treatment also clarifies the relation to formal modeling. Criticality can be analyzed through dynamical systems, stochastic processes, networks, agent-based simulations, field models, or other representations when their assumptions are justified. Formal analysis can sharpen transition hypotheses, while the practical decision still requires the epistemic, normative, historical, participatory, and responsibility architecture developed across the chapter. Section 11.12 now turns to these formal and quantitative model families and includes optimization as one locally specified mode of computational decision support within them.

11.12 Formal and Quantitative Decision Models

This section specifies the principal families of formal and quantitative models available to application-dominant praxis after the methodological disciplines developed in Sections 11.1–11.11. Its role is taxonomic and architectural rather than hierarchical. The objective is to identify what different model families represent, what practical questions they can support, which assumptions make their outputs meaningful, and how their results can be combined without collapsing distinct epistemic functions into a single formal language. The discussion proceeds from statistical and causal representations through dynamical, stochastic, network, field, operator, partial-order, history-weight, agent-based, and simulation models, then treats optimization and computational search as locally specified uses of formal representation, and concludes with sensitivity analysis, model risk, and the stronger assumptions required by amplitude-like constructions. Throughout, formal models remain locally justified representations under ontological suspension. Their important practical strengths can include explicit assumptions, internal consistency, operational specification, reproducible computation, empirical calibration or testing, and disciplined comparison across counterfactual or simulated states where the field permits these functions. Their practical authority nevertheless depends on the fit between representational structure and the historically evolving relational field rather than on mathematical

sophistication alone. Historical, interpretive, naturalistic, and participatory methods can disclose forms of provenance, meaning, tacit recognition, institutional context, and affected-position knowledge that formalization may compress, while those methods have their own limits of comparability, verification, transport, and dependence on situated judgment. Section 11.6 therefore treats methodological composition as a problem of reciprocal correction rather than a fixed hierarchy.

Definition 11.208 (Formal decision-model family). A *formal decision-model family* is a specified class of mathematical or computational representations that maps selected features of a practical configuration into objects, relations, transformations, histories, or comparison structures for the purpose of diagnosis, inference, scenario construction, decision support, intervention design, monitoring, or revision.

A formal model therefore enters a wider methodological architecture. Its inputs depend on observation regimes and epistemic events; its state variables and boundaries depend on practical diagnosis; its comparison rules depend on goals and criteria; and its outputs remain subject to institutional, normative, historical, and interpretive judgment. Section 11.4 established the analytical distinction between epistemic content and practical uptake when epistemic events become performatively coupled to later evolution. Sections 11.7–11.11 then showed that action spaces, histories, decision rules, evaluative frames, and even local response regimes can evolve. Formal decision models should preserve these possibilities where they are material to the practical problem.

Table 11.12 summarizes the principal families considered here. The rows should be read as interfaces rather than mutually exclusive boxes. A single practical model can combine several families: an agent-based simulation can evolve on a network; a dynamical system can contain stochastic transitions; a 2-complex history model can carry operator-valued labels; a causal model can be embedded in a simulation; and a scenario system can compare outputs from several formally heterogeneous models. The methodological requirement is to preserve what each component means and how information moves across their interfaces.

11.12.1 Statistical Forecasting

Statistical forecasting represents empirical regularities in observed or derived variables for the purpose of anticipating future observations, states, or indicators. Its strongest contribution is often predictive calibration within a specified data-generating and measurement regime. Forecasting can support resource preparation, scheduling, capacity planning, early warning, scenario comparison, and the monitoring of deviations from expected trajectories.

A generic predictive model can be written as Equation 11.19.

$$p^{(m)}(Y_{t+h} \mid \mathcal{I}_t), \quad h \geq 1, \quad (11.19)$$

where $\mathcal{I}_t$ denotes the information represented as available at stage t , Y_{t+h} is a future observable or derived quantity, and m identifies the forecasting model. Equation 11.19 is intentionally broad. The predictive object can be a point forecast, interval, distribution, quantile, categorical probability, or another model-specific representation.

Forecast accuracy and practical usefulness should remain distinct. A model can

Table 11.12: Formal and quantitative model families and their characteristic representational roles.

Model family	Primary representational object	Characteristic practical contribution
Statistical forecasting	Conditional regularities in observed data	Predictive distributions, intervals, short- to medium-horizon anticipation
Causal models	Intervention-sensitive dependency structure	Mechanism-sensitive counterfactual and intervention reasoning
Dynamical models	State evolution under transformation rules	Trajectories, attractors, thresholds, fast-slow change
Stochastic models	Transition structures with explicit randomness	Distributional uncertainty, path variation, stochastic transitions
Network / higher-order models	Relational topology and multi-actor interaction	Diffusion, concentration, coordination, systemic dependence
Field / operator models	Distributed conditions and transformation operators	Spatially or relationally varying influence and performative change
Operator algebra	Ordered composition of transformations	Sequence dependence, noncommutativity, intervention-order effects
Partial-order / 2-complex models	Historical-relational event structures	Event precedence, branching histories, extended subjects and relations
History weights / kernels	Relative support or transition structure over histories	Scenario weighting, accessibility, transition potential, updating
Agent-based models	Heterogeneous interacting computational agents	Emergence, adaptation, local rules, institutional and behavioral heterogeneity
Simulation	Generated ensembles of model trajectories	Stress testing, scenario exploration, mechanism experimentation
Optimization / search	Objectives, constraints, feasible regions, and search procedures	Conditional selection or design within an explicitly specified formal problem
Sensitivity analysis	Dependence of outputs on assumptions and inputs	Fragility diagnosis, influential parameters, structural comparison
Model-risk analysis	Uncertainty created by the modeling architecture	Boundary, specification, transport, implementation, and use risk
Amplitude-like models	Composition-sensitive complex-valued history objects	Optional interference-like or compositional structures under stronger semantics

predict an indicator accurately while omitting the relations through which an intervention would change that indicator. Conversely, a causal or dynamical model with weaker short-horizon predictive accuracy can still provide valuable intervention structure. Forecasting therefore answers a different methodological question from causal identification.

The information set $\mathcal{I}_t$ also carries historical and institutional assumptions. Observations can reflect classification systems, reporting incentives, sensor placement, missingness, strategic behavior, and earlier interventions. Where observation is performative, the forecasting process itself can change future data. A forecast published by a powerful institution can alter expectations, coordination, investment, or behavior, thereby becoming an epistemic event within the field represented by the forecast.

Definition 11.209 (Forecast-use profile). A *forecast-use profile* records the forecast object, horizon, data and observation regime, calibration domain, intended practical use, consequential decisions informed by the forecast, known performative effects,

and conditions under which predictive validity should be reassessed.

The profile prevents a forecast validated for one horizon, population, or observational regime from acquiring unsupported authority in another. It also makes forecast revision compatible with the model-versioning architecture developed in Section 11.10.

11.12.2 Causal Models

Causal models represent intervention-sensitive dependency structures. Their practical role is to distinguish patterns that help predict observations from structures that support claims about how selected changes can alter later outcomes or relational configurations. In application-dominant praxis, causal reasoning is especially important when a decision concerns intervention rather than passive anticipation.

A generic structural representation can be written as Equation 11.20.

$$X_j = f_j(\mathbf{Pa}_j, U_j), \quad j = 1, \dots, J, \quad (11.20)$$

where $\mathbf{Pa}_j$ denotes represented parent conditions for X_j , U_j collects exogenous or unresolved influences, and the family of functions f_j specifies the modeled generative dependencies. Equation 11.20 can be deterministic, stochastic, static, sequential, or embedded in a broader dynamical model.

The practical force of a causal model depends on more than graphical or algebraic form. Intervention semantics, temporal order, boundary assumptions, transport across contexts, measurement validity, and the stability of relevant mechanisms all matter. A model that supports a local intervention claim in one institutional setting can lose validity after the intervention changes actor incentives, institutional roles, or the observation regime itself.

GR also gives causal models a historical-relational interpretation. Causes need not be represented only as isolated variables. A causal condition can be a relational configuration, institutional arrangement, accumulated history, event sequence, or capacity structure. The relevant causal object can therefore be extended and path-dependent. In some applications, changing one event in a historical-relational subject requires regenerating downstream relations rather than treating the subject as unchanged apart from one variable.

Definition 11.210 (Practical causal claim). A *practical causal claim* is a scoped statement connecting a represented intervention or generative condition to a change in one or more later variables, relations, histories, capacities, or action possibilities under specified assumptions and contextual conditions.

Causal claims should travel with their scope. A decision can combine causal evidence from experiments, observational studies, historical comparison, mechanism analysis, simulation, or institutional knowledge while preserving disagreements among them. This keeps causal modeling inside the methodological pluralism established earlier in the book.

11.12.3 Dynamical Models

Dynamical models represent the evolution of a state or relational configuration under transformation rules. They are well suited to problems involving feedback, path

dependence, persistence, oscillation, attractors, thresholds, critical transitions, fast-slow processes, delayed effects, and changing intervention response.

A generic stage-dependent dynamical model is stated in Equation 11.21.

$$\omega_{t+1} = F_t^{(m)}(\omega_t, a_t, e_t; \theta_t), \quad (11.21)$$

where ω_t is the represented configuration, a_t is practical action, e_t is an epistemic or other event, and θ_t collects model parameters. Equation 11.21 explicitly permits epistemic events to alter later evolution, consistent with Section 11.4.

The state ω_t can itself be heterogeneous. It can contain continuous variables, categorical institutional states, relational networks, actor capacities, fields, or embedded historical objects. The transformation rule can also change through time. Section 11.8 introduced transformative histories in which the effective generative rule evolves; a dynamical model can therefore be extended to allow F_t to become an object of evolution rather than an immutable background law.

A useful dynamical representation should distinguish three questions. The first concerns the local response of the model around a represented configuration. The second concerns the larger qualitative structure of trajectories and basins. The third concerns whether the model itself remains appropriate as the practical field changes. A model that is locally accurate can become inadequate after an institutional transition, category change, or critical transformation.

Definition 11.211 (Dynamical validity region). A *dynamical validity region* is the set of represented configurations, time horizons, intervention magnitudes, parameter regimes, and institutional conditions within which a specified dynamical model is considered sufficiently adequate for its intended practical use.

This definition connects dynamical modeling to adaptive decision-making. Crossing the validity region can itself be an update condition that triggers model revision, additional observation, or a shift to another representation.

11.12.4 Stochastic Models

Stochastic models represent transition or observation structures in which modeled uncertainty is expressed through probabilistic objects. Their practical value arises where repeated variation, random disturbance, uncertain transitions, noisy observation, or distributional consequences are meaningfully represented probabilistically.

A generic stochastic transition kernel can be written as Equation 11.22.

$$K_t^{(m)}(d\omega' \mid \omega, a, e), \quad (11.22)$$

where the kernel assigns a model-specific probability measure over later configurations ω' conditional on the present configuration, action, and relevant event. Equation 11.22 has explicitly probabilistic semantics, in contrast with the more general transition-potential language used later in this section.

Probabilistic representation is strongest where probabilities have a defensible interpretation. The source can be repeated empirical frequencies, calibrated statistical models, explicit stochastic mechanisms, Bayesian uncertainty under stated assumptions, or another well-defined construction. Deep uncertainty, structural model disagreement, and unknown history spaces can exceed the scope of one stochastic kernel.

Those conditions call for the scenario, robustness, and model-plurality architectures developed in Sections 11.8 and 11.9.

Stochasticity can enter at several levels. The practical field can contain random disturbance; observation can be noisy; actor behavior can be represented probabilistically; parameters can be uncertain; and transitions between institutional states can carry stochastic components. These locations should remain distinguished because they imply different intervention and learning strategies.

Definition 11.212 (Stochasticity-location profile). A *stochasticity-location profile* records where probabilistic structure enters a model, what semantics justify it, which quantities remain structurally uncertain, and how stochastic assumptions affect practical conclusions.

The profile also helps prevent a probability distribution from absorbing uncertainty that is actually caused by contested boundaries, missing actors, changing mechanisms, or model-family disagreement.

11.12.5 Network and Higher-Order Models

Network models represent relational structure explicitly. They are useful where practical effects depend on connectivity, centrality, clustering, brokerage, dependency, diffusion, coordination, exposure, or the concentration of relational control. Higher-order models extend pairwise networks when interactions among three or more positions have irreducible structure for the practical question.

A basic network representation can be written as $G = (V, E, \lambda)$, where V contains represented positions, E contains pairwise relations, and λ contains relevant labels or attributes. A higher-order representation can add a family of interaction objects $\mathcal{E}^{(k)}$ for relations involving k positions. The resulting object is useful when the effect of a group relation cannot be reconstructed adequately from pairwise edges alone.

The meaning of an edge requires discipline. A communication tie, authority relation, trust relation, financial exposure, knowledge dependency, and shared institutional membership should not be treated as equivalent merely because each can be drawn as a line. Multiplex models can preserve several relation types simultaneously, while weighted or directed edges can represent asymmetry where justified.

Networks also interact with historical-relational subjects. A represented node can itself contain internal relational structure, memory, capacities, or an event history. A network of point nodes is therefore one modeling choice rather than a default ontology of social subjects. Nested or higher-order models can preserve the internal structure of selected subjects when that structure affects external relations.

Definition 11.213 (Relational representation profile). A *relational representation profile* records the meaning of nodes or positions, relation types, directionality, weights, higher-order interactions, temporal updating rules, observation boundaries, and the practical questions for which the relational representation is intended.

Network interventions can also change the topology that made the intervention attractive. Removing a central dependency, adding redundancy, creating a coordination hub, or changing an information channel can reorganize later diffusion and power. Decision support should therefore evaluate both immediate network effects and the generated relational architecture.

11.12.6 Field and Operator-Valued Models

Field models are useful where relevant conditions vary across space, relational position, scale, or another continuous or distributed domain. A field can represent opportunity, constraint, exposure, trust, information accessibility, institutional reach, environmental condition, or another distributed quantity. Operator-valued models become useful where local events or fields parameterize transformations of the represented configuration.

Let $\varphi_t(z)$ denote a model-specific field over positions z in a domain D . A distributed practical configuration can then be transformed through an operator family conditioned on the field. A schematic representation is stated in Equation 11.23.

$$\omega_{t+1} = \Phi_t[\varphi_t; a_t, e_t]\omega_t. \quad (11.23)$$

Equation 11.23 should be interpreted according to the chosen model. The bracketed field can parameterize a linear operator, nonlinear transformation, local update rule, or another transformation family. The notation does not imply a quantum ontology.

This representation is especially convenient for performative epistemic events. Observation can first produce a readout in a representation space, while recognition, classification, communication, or institutional uptake produces a field or operator that changes subsequent evolution. Section 11.4 established the typed distinction between these stages. Field and operator models provide one computational language for representing their coupling.

Definition 11.214 (Performative field). *A performative field is a model-specific distributed representation through which an epistemic, institutional, normative, or practical event alters the transformation conditions experienced across positions or relations in the represented configuration.*

A performative field can be local, heterogeneous, delayed, or scale-dependent. It can alter only selected parts of the configuration. This makes field representations useful where the same announcement, classification, rule, or signal has different consequences across relational positions.

11.12.7 Operator Algebra and Order-Sensitive Composition

Operator algebra provides a convenient formalism when practical transformations compose and the order of composition matters. Section 11.7 introduced order-sensitive decisions. The present subsection specifies how an operator representation can make that dependence explicit while preserving the distinction between formal composition and ontological claim.

Let Φ_a and Φ_b represent two practical or epistemically mediated transformations. Order sensitivity can be expressed by Equation 11.24.

$$\Phi_b \circ \Phi_a \neq \Phi_a \circ \Phi_b. \quad (11.24)$$

Equation 11.24 can represent many practical structures. Participation followed by design can produce a different institutional object from design followed by participation. Classification followed by resource allocation can differ from allocation followed by classification. Capability building before delegation can differ from dele-

gation before capability building. The inequality therefore represents path-sensitive composition where the model warrants it.

An operator algebra can include identity transformations, admissible composition, partial domains, inverses or approximate reversals, commutation relations, and distinguished subalgebras for different kinds of intervention. Partial operators are often appropriate because an action can be defined only on configurations satisfying particular institutional or capability conditions.

Definition 11.215 (Practical operator algebra). A *practical operator algebra* is a model-specific collection of transformations together with stated rules for admissibility, composition, order dependence, domain, and where relevant reversal or approximation, used to represent how practical or epistemic events transform a relational configuration.

Operator language becomes especially valuable when a decision problem concerns sequencing rather than isolated action selection. It can also expose when two interventions treated as interchangeable in prose actually have different composition structures.

11.12.8 Partial-Order and 2-Complex History Models

Partial-order and 2-complex models represent historical-relational structure directly. They are useful when event precedence is meaningful while a single total timeline would add unsupported ordering, or when subjects and relations possess higher-order historical organization that point-state models suppress.

A partially ordered event history can be represented as $(V, \preceq, \lambda)$, where V is a set of events, $\preceq$ is a precedence relation, and λ supplies model-specific labels. A labeled 2-complex can extend this structure through vertices, edges, and faces. A convenient schematic form is given in Equation 11.25.

$$\mathcal{C} = (V, E, F, \preceq, \lambda). \quad (11.25)$$

In Equation 11.25, the interpretation of vertices, edges, faces, precedence, and labels is model-specific. Vertices can represent events; edges can represent relational or transition structure; faces can represent higher-order composition, persistence, or interaction histories. The same mathematical object can support different semantics, so those semantics should be stated explicitly.

For historical-relational subjects, a 2-complex can preserve internal event structure together with external relations. A subject can therefore be represented as a finite subcomplex or a structured region of a larger history rather than as a timeless point. Practical interventions can add, remove, relabel, or reorganize parts of the complex, and epistemic events can change the represented continuation space.

Definition 11.216 (History-complex representation). A *history-complex representation* is a partial-order or cell-complex model in which events, relations, and higher-order historical structures are represented explicitly so that alternative continuations, composition, and subject persistence can be analyzed without reducing history to a sequence of independent states.

This family is particularly useful for scenario construction and trajectory credibility. It remains optional. A narrative, process-tracing, dynamical, graph, or agent-

based representation can preserve the relevant history more effectively in other applications.

11.12.9 History Weights and Transition Kernels

History weights and transition kernels provide formal mechanisms for differentiating among admissible futures. Section 11.8 introduced this architecture for scenario construction. The present subsection clarifies its role within a broader formal taxonomy.

Let $\mathcal{H}_t^{(m)}$ denote the model-specific admissible history family from stage t . A non-negative history-weight function is written in Equation 11.26.

$$W_t^{(m)} : \mathcal{H}_t^{(m)} \longrightarrow \mathbb{R}_{\geq 0}. \quad (11.26)$$

The semantics of Equation 11.26 can be probability, empirical frequency, plausibility, accessibility, simulation mass, transition propensity, or another explicitly defined quantity. Normalization is appropriate only where the chosen semantics require it.

A transition kernel can provide a more local construction. The general nonnegative form in Equation 11.27 does not yet assign probabilistic semantics.

$$K_t^{(m)}(\omega' \mid \omega, e, a) \geq 0. \quad (11.27)$$

Equation 11.27 can represent a transition potential, accessibility weight, or another local relation. If the kernel is normalized and given probability semantics, it becomes a stochastic transition model of the kind considered in Subsection 11.12.4. This typed distinction prevents generic history weighting from being silently interpreted as probability.

Epistemic events can affect these models in at least two different ways. They can reweight histories already present in $\mathcal{H}_t^{(m)}$, or they can change the history family itself by generating or foreclosing branches. These operations should remain distinct because the second changes the support of the future representation rather than only the relative weight assigned within a fixed support.

Definition 11.217 (History-weight provenance). A *history-weight provenance record* states the semantics, empirical or theoretical basis, normalization rule where applicable, updating procedure, scope, and known limitations of a history-weight or transition-potential construction.

This provenance is essential when weighted histories inform consequential decisions. A visually precise weighted scenario tree can otherwise conceal a highly contestable interpretation of what its weights mean.

11.12.10 Agent-Based Models

Agent-based models represent heterogeneous interacting computational agents whose local rules generate larger-scale patterns. They are useful when aggregate behavior emerges from adaptation, bounded information, local interaction, institutional rules, network position, learning, imitation, strategic response, or heterogeneous capacities.

A generic agent update can be written as Equation 11.28.

$$s_{i,t+1} = G_i^{(m)}(s_{i,t}, \mathcal{N}_{i,t}, \omega_t, a_t, e_t; \theta_i), \quad (11.28)$$

where $s_{i,t}$ is the represented state of agent i , $\mathcal{N}_{i,t}$ summarizes relevant relational neighbors or interaction structure, and the remaining terms represent field, action, event, and agent-specific parameters. Equation 11.28 can be deterministic or stochastic.

The word *agent* is a computational role rather than a complete theory of subjectivity. A historical-relational subject can be represented by one computational agent, several interacting sub-agents, a structured internal model, or another object. The appropriate representation depends on whether internal history and relations materially affect the practical question.

Agent-based models are especially useful for examining emergent consequences of rules that are locally simple but collectively complex. They can explore coordination, diffusion, segregation, institutional learning, strategic adaptation, trust, and the performative response to decision rules. Their flexibility also creates model risk: behavioral rules, calibration, initialization, network structure, and adaptation assumptions can strongly shape the generated histories.

Definition 11.218 (Agent-rule provenance). An *agent-rule provenance record* states how agent types, behavioral rules, learning rules, interaction structures, heterogeneity, initialization, and calibration were constructed and which practical claims they are intended to support.

Agent-based outputs should therefore be interpreted as conditional consequences of a specified generative architecture rather than direct predictions of social behavior unless stronger validation supports that use.

11.12.11 Simulation

Simulation generates model trajectories by executing a formal representation under specified initial conditions, parameters, interventions, events, and stochastic realizations. Its practical value lies in exploring consequences that are analytically difficult to derive, stress-testing mechanisms, comparing pathways, and exposing interactions among assumptions.

A simulation ensemble can be represented schematically as Equation 11.29.

$$\mathcal{S}^{(m)} = \left\{ h_r^{(m)} \mid r = 1, \dots, R \right\}, \quad (11.29)$$

where $h_r^{(m)}$ is one generated trajectory or history under model m . The ensemble can arise from stochastic draws, parameter sweeps, different scenarios, alternative interventions, or combinations of these sources.

Simulation does not create evidence by itself. A simulation result is evidence about the behavior of the specified model under the stated conditions. Its relevance to the practical world depends on model adequacy, calibration, validation, correspondence between simulated and observed objects, and the intended inferential task.

This distinction is particularly important for exploratory simulation. A model can be useful because it reveals a possible mechanism, threshold, failure mode, or unex-

pected interaction even when it is not calibrated for prediction. Conversely, a well-calibrated simulator can still omit institutional or historical structures that matter for intervention.

Definition 11.219 (Simulation-use class). A *simulation-use class* specifies whether a simulation is being used primarily for exploration, explanation, prediction, stress testing, design comparison, training, or another practical function, together with the validation burden appropriate to that function.

Simulation should therefore be linked to the epistemic task it performs. The same computational output can carry different practical authority when used for exploration than when used to justify a high-stakes irreversible commitment.

11.12.12 Optimization and Computational Search

Optimization and computational search are formal procedures for comparing candidate actions, designs, schedules, trajectories, or parameter configurations after a practical problem has been represented through objectives, constraints, feasible regions, transition assumptions, or other comparison structures. Their methodological role is local: they can identify solutions within a specified formalization while leaving open whether that formalization captures all considerations relevant to practical commitment.

A basic local optimization problem can be expressed in Equation 11.30.

$$a^* \in \arg \operatorname{opt}_{a \in \mathcal{F}_t^{(m)}} J_t^{(m)}(a), \quad (11.30)$$

where $J_t^{(m)}$ denotes a model- and stage-specific objective or comparison functional and $\mathcal{F}_t^{(m)}$ denotes the represented feasible region. Equation 11.30 is intentionally local. The objective can be scalar, vector-valued, lexicographically ordered, constrained by protected conditions, or embedded in a dynamic or robust problem. The feasible region can also change as capacities, authority, institutions, knowledge, or earlier choices alter the action space.

Optimization therefore inherits the situated evaluative architecture of Section 11.3. A scalar objective can be appropriate when the relevant practical dimensions admit a justified common ordering. Multiple objectives can remain vector-valued when scalarization would suppress important value structure. Constraints can represent material limits, institutional authority, legal requirements, safety conditions, ecological boundaries, or other locally justified restrictions, but their formal appearance does not make these heterogeneous meanings interchangeable.

The result is also model-dependent. Different boundaries, transition rules, horizons, uncertainty sets, subject representations, or conversion rules can produce different optima without any computational error. Robust optimization can compare performance across a specified uncertainty set, and dynamic optimization can represent temporally linked decisions, while the broader robustness architecture of Section 11.9 remains available for uncertainties and values that do not fit one optimization problem.

Definition 11.220 (Optimization-use profile). An *optimization-use profile* records the objective or comparison rule, feasible-set construction, constraints, temporal horizon,

model family, uncertainty representation, value-conversion assumptions, search procedure, and practical conclusion for which an optimization result is being used.

Non-convexity, discrete institutional rules, changing action spaces, path dependence, and critical-transition uncertainty can make local optima or locally calibrated objectives poor guides to wider practical judgment. These conditions do not remove the value of optimization. They specify the domain in which an optimization result should be interpreted. Near a possible qualitative transition, for example, the relevant question can shift from finding the best point inside one regime to comparing histories that enter different regimes, as developed in Section 11.11.

Optimization and computational search therefore belong inside the formal-method repertoire rather than above it. They can organize large decision spaces, reveal binding constraints, identify efficient regions, and support design exploration. Final practical commitment still depends on the epistemic, normative, historical, participatory, responsibility, and reversibility conditions developed elsewhere in the chapter.

11.12.13 Sensitivity Analysis

Sensitivity analysis examines how model outputs, decisions, rankings, or qualitative conclusions depend on parameters, assumptions, initial conditions, boundaries, criteria, and structural choices. Its practical role is to expose where apparent precision is supported by stable structure and where it depends on fragile modeling decisions.

For a scalar output $Q(\theta)$, a local sensitivity can be represented by Equation 11.31.

$$S_j = \frac{\partial Q}{\partial \theta_j}, \quad (11.31)$$

where the derivative is meaningful only when the model and parameterization support such local analysis. Equation 11.31 is one narrow form of sensitivity analysis. Finite perturbations, global sensitivity, scenario comparison, structural alternatives, boundary variation, and model-family comparison can be more appropriate where the response is nonlinear, discontinuous, categorical, or historically path-dependent.

GR broadens the object of sensitivity beyond numerical parameters. A practical conclusion can be sensitive to:

- the represented subject boundary;
- relation type or network topology;
- event order;
- history-space construction;
- observation regime;
- criterion priority;
- institutional implementation assumption;
- model family itself.

These forms of sensitivity should be recorded even where they cannot be differentiated numerically.

Definition 11.221 (Decision-sensitivity profile). A *decision-sensitivity profile* records the parameters, assumptions, boundaries, model structures, criteria, histories, and institutional conditions whose plausible variation materially changes a practical con-

clusion, together with the direction and practical significance of that change where these can be characterized.

Sensitivity analysis connects directly to robustness. A highly sensitive model can still support a robust decision if the relevant variations leave all admissible conclusions within an acceptable region. Conversely, a numerically stable output can conceal structural fragility if the model family or boundary is wrong.

11.12.14 Model Risk

Model risk is the practical risk generated by relying on a representation that is incomplete, misspecified, transported beyond its validated domain, poorly implemented, strategically manipulated, or assigned more authority than its epistemic status supports. Model risk therefore concerns both the model and the institutional relation through which model output enters consequential praxis.

Definition 11.222 (Model risk). *Model risk* is the possibility of materially adverse practical consequence arising from the construction, estimation, calibration, implementation, interpretation, governance, or use of a formal model and from mismatch between the model's representational scope and the practical conclusion drawn from it.

A useful model-risk decomposition distinguishes several loci. *Boundary risk* concerns omitted actors, relations, scales, or histories. *Specification risk* concerns incorrect or inadequate model structure. *Parameter risk* concerns uncertain or unstable parameter values. *data and observation risk* concerns measurement, selection, missingness, or performative observation. *transport risk* concerns use outside the context in which the model was supported. *implementation risk* concerns errors in software, numerical procedures, interfaces, or organizational execution. *use risk* concerns interpreting the model beyond the claims it can support. *governance risk* concerns concentration of authority, opacity, weak contestability, or lack of responsibility for model revision.

Model plurality can reduce some forms of model risk by exposing structural dependence, while it can create additional coordination and interpretation burdens. Independent models that share the same omitted boundary or data-generating assumptions do not provide independent protection merely because their mathematical forms differ.

Definition 11.223 (Model-risk register). A *model-risk register* records material model dependencies, known failure modes, validation limits, monitoring signals, responsible positions, version history, fallback models or non-model procedures, and conditions for suspension, revision, or retirement.

The register converts model risk into an object of ongoing governance. This becomes especially important for models embedded in automated systems, institutional routines, or long-lived infrastructure where the model can continue shaping action after its original assumptions have changed.

11.12.15 Amplitude-Like Models under Stronger Assumptions

Amplitude-like models form an optional extension of the history-based architecture. They become potentially useful where the intended formalism requires composition-

sensitive complex-valued objects whose phases or interference-like relations have a defined analytical role. Their use requires substantially stronger semantics than the nonnegative history weights and transition potentials introduced in Subsection 11.12.9.

Let an amplitude-like assignment be represented by Equation 11.32.

$$A^{(m)} : \mathcal{H}^{(m)} \longrightarrow \mathbb{C}. \quad (11.32)$$

Equation 11.32 alone provides a complex-valued label over histories. It does not yet specify how amplitudes compose, how alternatives combine, what phase means, how an observation is represented, or how the resulting object maps to empirically or practically interpretable quantities.

For a family of histories $B \subseteq \mathcal{H}^{(m)}$, one possible compositional object is stated in Equation 11.33.

$$\mathcal{A}^{(m)}(B) = \sum_{h \in B} A^{(m)}(h). \quad (11.33)$$

Equation 11.33 becomes analytically meaningful only after the model specifies why histories should compose through complex addition and what empirical or conceptual phenomenon is represented by the resulting phase-sensitive quantity. A further mapping from $\mathcal{A}^{(m)}(B)$ to an observable or decision-relevant measure also requires explicit justification.

Definition 11.224 (Amplitude-semantics package). An *amplitude-semantics package* specifies the meaning of the complex-valued history object, composition rule, phase structure, observation or readout map, empirical interpretation, calibration or estimation procedure where applicable, and the additional explanatory or computational value obtained relative to a nonnegative history-weight model.

A 2-complex representation does not by itself supply this package. Spin-foam-inspired combinatorial structure, partial ordering, or operator composition can be useful without importing quantum amplitudes. Amplitude-like models become justified only where their stronger structure performs an identified analytical task that simpler representations cannot perform adequately.

This discipline preserves openness. Future GR work can develop amplitude-like or other richer history formalisms where they prove useful, while current applied methodology can rely on statistical, causal, dynamical, stochastic, network, operator, partial-order, simulation, and nonnegative history-weight models according to problem structure.

Proposition 11.225 (Representational plurality of formal decision models). *No single formal family considered in this section is sufficient by virtue of mathematical form alone for the full range of application-dominant praxis. Practical adequacy depends on which actors, relations, histories, transformations, uncertainties, values, scales, and institutional conditions the model preserves, together with how its outputs are interpreted and revised.*

The practical consequence of Proposition 11.225 is methodological combination with preserved interfaces. A statistical forecast can anticipate a near-term quantity, a causal model can represent an intervention mechanism, a network model can reveal concentrated dependency, a dynamical model can expose a threshold, an agent-based

simulation can explore adaptation, and a history model can preserve event order and long-horizon branching. Their outputs can inform one practical architecture while retaining their distinct assumptions and epistemic roles.

Formal and quantitative models also leave remainders. Categories can have contested meanings; institutional rules can operate differently from their formal specification; actors can interpret and strategically respond to models; historical experience can change the meaning of apparently identical variables; and values can resist commensuration. Section 295 therefore turns to historical and interpretive practical analysis. Its role is complementary: to reconstruct meanings, trajectories, institutional formation, classification, narrative, and situated understanding that formal models can use, challenge, or leave deliberately unresolved.

11.13 Historical and Interpretive Practical Analysis

Formal and quantitative decision models make selected structures, dependencies, trajectories, uncertainties, and transformation rules explicit. Application-dominant praxis also encounters practical objects whose identity and consequence depend materially on historical formation, institutional memory, situated meaning, interpretation, and the ways actors understand the relations in which they participate. The role of the present section is to specify historical and interpretive practical analysis as a positive methodological family within applied praxis. Its objective is to reconstruct how practical configurations became possible, how historically formed subjects and institutions carry earlier events into present action, how meanings organize response, and under what conditions an interpretation developed in one setting can inform another. The discussion proceeds through historical precedent, historical-relational subject reconstruction, institutional memory, path dependence, contextual interpretation, legal interpretation, cultural meaning, local knowledge, narrative understanding, and conditions of interpretive transfer. The method is reconstructive and comparative. Historical and interpretive materials are treated as disciplined forms of access whose claims remain evidentially constrained, revisable, and interoperable with the formal and quantitative methods developed in Section 11.12.

Definition 11.226 (Historical and interpretive practical analysis). *Historical and interpretive practical analysis* is a family of application-oriented methods that reconstructs temporal formation, historically extended subjects, institutional memory, path dependence, situated meanings, rule interpretation, cultural significance, local practical knowledge, and narrative configuration in order to improve practical diagnosis, decision, intervention, evaluation, and revision.

The object of analysis can be an institution, subject, category, relation, practice, event sequence, rule, narrative, or practical field. Different objects call for different evidential materials. Archival records, administrative documents, legal texts, institutional records, interviews, correspondence, testimony, artifacts, observational records, local classifications, and prior evaluations can each contribute where their provenance and representational limits are understood. Historical and interpretive analysis therefore has its own evidential architecture rather than functioning as unrestricted contextual commentary.

Table 11.13 summarizes the analytical dimensions developed below. The rows are

Table 11.13: Historical and interpretive dimensions of practical analysis.

Analytical dimension	Primary practical object	Characteristic contribution
Historical precedent	Earlier practical episodes and trajectories	Comparison of prior conditions, responses, consequences, and transfer assumptions
Subject reconstruction	Historically extended relational subjects	Recovery of formative events, internal relations, capacities, classifications, and changing standing
Institutional memory	Records, routines, precedents, skills, and inherited obligations	Preservation and reconstruction of prior learning, reasons, failures, and unresolved commitments
Path dependence	Sequentially generated constraints and capabilities	Identification of reinforcement, lock-in, option generation, and historically contingent reachability
Contextual interpretation	Situated meanings and practical understandings	Interpretation of actions, categories, and evidence within their operative setting
Legal interpretation	Rules, authorities, precedents, and institutional competence	Reconstruction of operative legal meaning, authorization, obligation, and contestability
Cultural meaning	Symbols, conventions, identities, expectations, and practices	Analysis of meaning-mediated response and practical acceptability
Local knowledge	Situated experiential and operational knowledge	Recovery of field-level mechanisms, constraints, capacities, and early signals
Narrative understanding	Temporal accounts linking events, actors, and consequences	Reconstruction of practical sense-making, responsibility, expectation, and future orientation
Interpretive transfer	Translation across settings, times, institutions, and categories	Identification of correspondence, remainder, transformation, and conditions of portability

mutually connected. A historical precedent is interpreted through categories; institutional memory is carried through narratives and records; local knowledge can reveal path-dependent constraints; legal interpretation operates within institutional histories; and cultural meaning can shape the practical effects of otherwise similar formal interventions. The purpose of differentiation is therefore analytical clarity rather than methodological isolation.

11.13.1 Historical Precedent

Historical precedent provides practical material for comparison among earlier situations, interventions, failures, repairs, and institutional responses. Its use is strongest when the comparison reconstructs the conditions that made an earlier episode comparable to the present case. A prior intervention can inform present judgment through mechanism, sequencing, institutional capacity, implementation difficulty, distributional consequence, or failure pattern even when the earlier case differs in other respects.

Definition 11.227 (Historical precedent profile). A *historical precedent profile* records the earlier practical situation, relevant actors and relations, problem formulation, institutional conditions, available action space, intervention sequence, observed consequences, unresolved uncertainty, and the dimensions on which comparison with the present situation is being made.

The profile prevents a precedent from operating as an unexamined analogy. Sim-

ilar surface outcomes can emerge from different generative relations, while apparently different episodes can share important structural mechanisms. Practical use therefore depends on specifying the dimension of correspondence. A precedent can be informative because it shares an institutional bottleneck, a sequencing problem, a particular dependence relation, or a form of implementation failure even where the substantive domain differs.

Historical precedent also contains negative information in a broad sense: abandoned alternatives, failed coordination, missing capabilities, unintended consequences, and pathways that were later repaired can all enlarge the present action space. Earlier actors may also have faced options that no longer exist, while present actors may possess capacities unavailable before. A useful precedent profile therefore records historical action spaces and later transformations rather than comparing only realized outcomes.

The interpretation of precedent remains temporally situated. Categories, legal authorities, infrastructures, communication technologies, social expectations, and institutional capacities can change. A successful earlier intervention can consequently become poorly transportable after the surrounding relational field changes. Historical precedent supports practical reasoning when it is reconstructed as a conditional relation among situations, responses, and consequences rather than as a timeless template.

11.13.2 Historical-Relational Subject Reconstruction

Application-dominant praxis often depends on subjects whose present capacities, identities, obligations, vulnerabilities, and expectations are products of earlier relations and events. Historical-relational subject reconstruction preserves this temporal structure. Its practical purpose is to avoid treating a subject as a point-like bearer of fixed attributes when the relevant practical object is better understood as an extended configuration with internal history and external relations.

Definition 11.228 (Historical-relational subject reconstruction). *Historical-relational subject reconstruction* is the method of representing a practical subject through the events, relations, classifications, capacities, institutional positions, commitments, and transformations that materially constitute its present practical configuration.

The reconstructed subject can be an individual, organization, institution, community, technical system, collective, or another bounded practical object where that boundary is itself methodologically justified. Relevant history can include formative decisions, membership changes, contractual or legal transformations, resource accumulation, prior harms, learning, institutional recognition, loss of capacity, and changes in relational position. The reconstruction therefore differs from a chronological biography. It selects historical structure according to the practical question while recording the exclusions that selection creates.

Where formal analysis benefits from explicit event structure, a historical-relational subject can be represented through partially ordered events, networks, higher-order relations, labeled 2-complexes, or other models discussed in Section 11.12. Historical and interpretive reconstruction supplies meaning and provenance to those formal objects. A vertex can represent an event only after the event has been identified and interpreted; an edge can represent a relation only after its substantive meaning and temporal scope have been specified. Formal and interpretive representations there-

fore constrain and correct one another.

Definition 11.229 (Subject-history dossier). A *subject-history dossier* is a versioned record of the formative events, relations, classifications, capabilities, obligations, disputed interpretations, and boundary assumptions used to reconstruct a historical-relational subject for a specified practical purpose.

The dossier also supports revision. An epistemic event can reveal a previously omitted relation, change the interpretation of an earlier event, or alter the subject through recognition and institutional uptake. Subject reconstruction therefore participates in the evolving-field architecture developed in Sections 11.4–11.10.

11.13.3 Institutional Memory

Institutional memory concerns the practical persistence of knowledge, reasons, capabilities, commitments, failures, and unresolved questions across time. Records are one component of memory, while operative memory also depends on retrieval, interpretation, role continuity, training, routines, authority, and interfaces through which past information can inform present action. A large archive can coexist with weak institutional memory when records are inaccessible, decontextualized, or disconnected from decision processes.

Definition 11.230 (Practical institutional memory). *Practical institutional memory* is the capacity of an institution or collective to preserve, retrieve, interpret, and operationally reconnect materially relevant records, reasons, experiences, skills, responsibilities, and unresolved questions across changes in personnel, structure, and practical context.

Historical and interpretive analysis can reconstruct institutional memory from decision records, correspondence, procedural histories, operational routines, earlier evaluations, maintenance logs, legal or administrative materials, and the recollections of participants. The objective is not merely to recover what happened. It is to establish which reasons and constraints informed earlier action, how later actors inherited them, and where information or responsibility was lost during institutional transmission.

A useful applied object is the *memory interface*: the procedure or relation through which an earlier practical state becomes available to later actors. Handover documents, institutional repositories, recurring review procedures, professional communities, shared technical standards, and durable roles can each function as memory interfaces. Their reliability depends on selection, accessibility, interpretability, and preservation of context.

Institutional forgetting can itself become a generative condition. A temporary exception can harden into routine after its original justification is forgotten; an earlier failure can recur after diagnostic knowledge disappears; or a historical obligation can remain materially active while losing explicit institutional recognition. Practical diagnosis should therefore ask both what an institution remembers and what its current memory architecture makes difficult to recover.

11.13.4 Path Dependence

Path dependence analyzes how earlier events and sequences alter later possibilities, costs, capacities, expectations, and institutional arrangements. Its practical importance lies in distinguishing a present constraint that is technically necessary from one produced historically through reinforcement, investment, coordination, classification, learning, or accumulated commitment. The same present configuration can therefore carry different revision possibilities depending on how it was formed.

Definition 11.231 (Practical path dependence profile). A *practical path dependence profile* reconstructs the sequence of materially relevant events and reinforcement mechanisms through which earlier states or decisions altered the reachability, cost, legitimacy, capacity, or consequence structure of later practical options.

The profile can include increasing returns, network effects, sunk investment, legal commitments, organizational learning, trust formation, accumulated maintenance, category stabilization, or other mechanisms where they are empirically and interpretively supported. The method should identify the pathway connecting earlier events to present consequences. Historical sequence alone does not establish path dependence.

Path dependence can constrain action, but it can also generate capability. A durable institution, accumulated expertise, trusted coordination routine, or maintained infrastructure can create future possibilities precisely because earlier action has been reinforced. Practical analysis therefore tracks both *path-generated constraint* and *path-generated capacity*. This dual structure is important for intervention design: dismantling a constraining arrangement can also destroy useful capabilities embedded in the same historical pathway.

Historical reconstruction further helps distinguish lock-in from provisional stability. A stable arrangement can remain revisable when alternative capabilities and institutional pathways survive. Lock-in becomes practically stronger as alternatives are depleted, switching costs accumulate, or the field changes so that earlier options cease to be reachable. This connects historical interpretation directly to the evolving action-space architecture in Section 11.7 and the locally specified optimization and feasible-set representations in Section 11.12.

11.13.5 Contextual Interpretation

Contextual interpretation reconstructs what an action, category, observation, or institutional practice means within the practical relations in which it operates. The same formally described act can carry different practical meanings when its authority, audience, history, expectations, or relational position changes. Interpretation therefore contributes information that is not recoverable from syntax or behavior alone.

Definition 11.232 (Contextual interpretation). *Contextual interpretation* is the disciplined reconstruction of the situated meanings, reasons, expectations, categories, and practical understandings through which an action, statement, rule, observation, or relation becomes intelligible within a specified field.

Contextual interpretation is evidentially constrained. Participant accounts, observed practices, records, material arrangements, institutional rules, prior events, and alternative readings can support or challenge an interpretation. Disagreement among actors is itself relevant evidence because a practical field can contain multi-

ple operative meanings. The analyst should therefore distinguish shared meaning, contested meaning, strategic representation, retrospective reinterpretation, and external analytical interpretation where these differences matter.

Interpretation can also affect the field. A public classification, official explanation, diagnostic label, or institutional narrative can be recognized by actors and become an epistemic event in the sense developed in Section 11.4. Once uptake changes expectations, rights, obligations, coordination, or self-understanding, interpretation has become coupled to transformation. Historical and interpretive analysis therefore contributes to the performative-observation architecture rather than standing outside it.

Definition 11.233 (Interpretive provenance record). A *interpretive provenance record* identifies the materials, positions, temporal context, alternative readings, unresolved ambiguities, and practical consequences associated with a materially important interpretation.

The record becomes especially useful when interpretive conclusions inform high-consequence action. It preserves the difference between what participants said, what institutions formally recorded, what the analyst inferred, and how later practical events changed the interpretation.

11.13.6 Legal Interpretation

Legal interpretation enters practical analysis where authority, obligation, permission, standing, procedure, liability, rights, jurisdiction, or institutional competence materially shape the action space. Its practical object is broader than the text of a rule. Applicable sources, institutional practice, authoritative interpretation, factual classification, procedural posture, and temporal validity can jointly determine what a rule means for a particular practical situation.

Definition 11.234 (Legal-interpretive practical profile). A *legal-interpretive practical profile* records the relevant legal or rule-governed sources, interpretive authority, jurisdiction or institutional competence, material factual classifications, procedural conditions, contested interpretations, temporal status, and practical consequences for the action space.

This profile is methodological rather than a substitute for professional legal judgment. Its role within GR is to prevent a decision model from treating law as a static binary constraint when the practical operation of a rule depends on interpretation, institutional authority, exception, procedure, interaction among sources, or change through time. Where legal uncertainty is consequential, the uncertainty belongs inside the decision architecture rather than being hidden behind a fixed feasibility flag.

Legal categories can also be performative. Recognition of a subject under a legal status can change rights, obligations, eligibility, standing, institutional responsibilities, and available actions. An interpretive event can therefore transform the practical field. Conversely, a formal entitlement can remain weakly effective where institutional capacity, information, enforcement, or access is absent. Legal interpretation should consequently be connected to the relational and institutional diagnosis rather than treated as text retrieval alone.

Comparative use requires caution because legal meaning is strongly dependent on institutional setting, hierarchy of authority, temporal validity, and procedural context. Similar wording across systems does not establish equivalent practical opera-

tion. Conditions of transfer are addressed directly in Subsection 11.13.10.

11.13.7 Cultural Meaning

Cultural meaning concerns symbols, conventions, expectations, practices, identities, categories, and shared or contested forms of significance that mediate practical response. An intervention can be materially identical across two settings while producing different consequences because actors interpret its form, source, timing, symbolism, or relational implication differently. Cultural meaning can therefore affect uptake, refusal, trust, legitimacy, coordination, and the generation of later options.

Definition 11.235 (Cultural-meaning profile). A *cultural-meaning profile* reconstructs the symbols, conventions, classifications, identities, expectations, practical norms, and contested meanings that materially mediate how a practical object or intervention is interpreted and enacted within a specified field.

The profile should avoid converting culture into a homogeneous group attribute. Cultural fields can contain internal disagreement, cross-cutting identities, institutional variation, generational change, strategic use of symbols, and rapid transformation. A practical analysis therefore reconstructs the relevant meaning relations at the scale required by the decision rather than assuming uniformity from broad labels.

Meaning can itself change through intervention. New practices can become normalized; categories can acquire new symbolic associations; an institutional response can transform expectations; and repeated participation can generate a shared vocabulary that did not previously exist. Cultural analysis therefore concerns both inherited meanings and *meaning-generative effects* of praxis.

For decision methodology, the key contribution is often interpretive sensitivity. A technically efficient option can become practically weak if it produces distrust, symbolic exclusion, or category mismatch. Conversely, a modest material change can have substantial practical consequence when it alters recognition, legitimacy, or relational meaning. These consequences should be documented rather than silently translated into a generic preference parameter unless such a representation is locally justified.

11.13.8 Local Knowledge

Local knowledge is knowledge generated through situated participation in a practical field. It can concern operational routines, environmental conditions, informal institutions, timing, exception handling, social relations, tacit warning signals, resource constraints, or the practical meaning of categories. Its importance follows from differentiated epistemic position: actors located at different points in a relational field can have access to different aspects of the same practical configuration.

Definition 11.236 (Local practical knowledge). *Local practical knowledge* is situated knowledge acquired through participation, experience, observation, practice, or sustained relation within a specific practical field and whose warrant and scope depend materially on that situated access.

Local knowledge is neither automatically privileged nor automatically inferior to expert or formal knowledge. Its epistemic contribution depends on the object. Front-

line actors can observe implementation failure before central indicators register it; affected subjects can identify burdens omitted from administrative categories; technical experts can identify mechanisms inaccessible to everyday observation; comparative analysts can detect patterns unavailable within one local field. Practical methodology should therefore construct interfaces among differentiated knowledge positions.

A *local-knowledge interface* records how situated claims enter wider decision processes, including translation, verification, aggregation where appropriate, protection against retaliation, feedback to contributors, and treatment of disagreement. Such interfaces are important because institutions can extract local knowledge without transferring interpretive authority or practical influence. The resulting record should preserve both the contribution and the relational conditions under which it was produced.

Local knowledge can also be time-sensitive. A practice that worked under one institutional regime can lose validity after infrastructure, law, ecology, technology, or social relations change. Versioning and provenance therefore apply to local knowledge as they do to formal models.

11.13.9 Narrative Understanding

Narrative understanding organizes events into temporally and causally intelligible accounts. In practical fields, narratives can connect origin, responsibility, injury, progress, decline, identity, expectation, and imagined futures. They influence which events are treated as significant, which actors receive agency, what consequences count as continuation or rupture, and which future actions appear plausible or legitimate.

Definition 11.237 (Practical narrative configuration). A *practical narrative configuration* is a situated organization of actors, events, temporal relations, causal or moral significance, and anticipated futures through which a practical field becomes intelligible to one or more positions.

Narrative analysis should distinguish a narrative from the history it organizes. Coherent narrative form can omit events, compress uncertainty, assign agency selectively, or stabilize a particular causal interpretation. Competing narratives can therefore be compared against records, sequence, institutional evidence, and alternative accounts. Their practical importance can remain high even when their historical adequacy differs, because actors can organize action around narratives they treat as meaningful.

Narratives are also generative. A narrative of inevitable decline can alter investment and coordination; a narrative of institutional recovery can support cooperation; an official account of failure can allocate responsibility and define what reforms become conceivable. Once circulated and taken up, a narrative can function as an epistemic event that changes the field it describes.

Definition 11.238 (Narrative consequence profile). A *narrative consequence profile* records the practical positions that produce or receive a narrative, the events and relations it foregrounds or omits, its evidential support and contested elements, and the ways its uptake can alter expectations, responsibility, coordination, recognition, or future action spaces.

Narrative understanding therefore interfaces directly with scenario construction. Scenarios in Section 11.8 can be formally generated, narratively communicated, or both. The narrative form through which a modeled history is presented can affect how actors interpret its plausibility and urgency. Practical use should preserve the distinction between model structure and narrative presentation while analyzing their interaction.

11.13.10 Conditions of Interpretive Transfer

Historical and interpretive conclusions often need to travel across cases, institutions, times, languages, or practical domains. Transfer is possible when the analyst can identify which relations, meanings, mechanisms, or institutional conditions remain sufficiently corresponding for the earlier interpretation to retain practical relevance. The relevant object is therefore conditional portability rather than presumed universality.

Definition 11.239 (Interpretive transfer). *Interpretive transfer* is the disciplined use of a historically or contextually grounded interpretation in a different practical setting through explicit reconstruction of correspondence, transformation, remainder, and conditions of validity.

A transfer analysis should compare the source and target settings along dimensions that matter to the claim. These can include category meaning, institutional authority, actor position, temporal structure, legal setting, cultural convention, material infrastructure, capability, path dependence, language, and observation regime. Exact similarity is unnecessary. The objective is to establish whether the relation supporting the interpretation persists, has transformed, or has disappeared.

Definition 11.240 (Interpretive transfer profile). An *interpretive transfer profile* records the source context, target context, proposed correspondence, transformed elements, unresolved differences, material remainders, evidential basis, and conditions under which the transferred interpretation should be revised or withdrawn.

The concept of a *transfer remainder* is especially important. Some meanings, institutional relations, historical burdens, or category distinctions can resist translation into the target setting. Preserving that remainder is preferable to forcing apparent equivalence. A transfer can therefore be partial while remaining useful.

Transfer also works in the opposite direction. A target setting can reveal that the source interpretation was oversimplified, because the attempt at translation exposes an assumption previously treated as background. Comparative practical analysis can consequently revise both source and target understanding. This is consistent with the wider GR commitment to methodological recursivity: application across settings can itself become an epistemic event that changes the interpretation being transferred.

Proposition 11.241 (Historically situated practical interpretation). *Historical and interpretive practical analysis supports consequential praxis most strongly when temporal formation, situated meaning, evidential provenance, alternative interpretations, and transfer conditions remain explicit enough for the interpretation to be contested, revised, and combined with other methodological representations.*

The practical consequence of Proposition 11.241 is methodological complementarity. Historical reconstruction can revise a supposedly fixed feasible set; legal interpretation can alter institutional admissibility; local knowledge can reveal implemen-

tation mechanisms; narrative analysis can identify performative meaning; and cultural interpretation can disclose why formally similar interventions generate different responses. Formal models can in turn test internal consistency, expose hidden assumptions, organize comparison, and show where an interpretive account implies consequences that require further evidence.

Historical and interpretive analysis also clarifies the next methodological problem. Practical meaning and knowledge are distributed across affected subjects, institutions, experts, representatives, and other participants. Methods are therefore required for deciding whose knowledge enters a practical process, through which representation, under what conditions of voice and authority, and with what capacity to contest the resulting decision architecture. Section 296 consequently turns to participatory decision methods.

11.14 Participatory Decision Methods

Section 11.13 established that practical knowledge, meaning, and historical understanding are distributed across differently situated subjects, institutions, experts, representatives, and local participants. The present section develops the methodological architecture required when consequential decisions must draw on that distributed knowledge while also allocating voice, representation, authority, burden, and contestability. Its role within Chapter 11 is to translate the domain-general participation architecture developed in Chapter 10 into operational decision methods. Its objective is to specify how stakeholders and affected subjects are identified, how deliberation and participatory mapping are organized, how co-design differs from consultation, how representation and voice are governed, how participation can function as an epistemic event, how contestability is preserved, and how unequal participation is diagnosed and mitigated. The method is relational and procedural. Participation is treated as a sequence of practically consequential interfaces rather than as a binary property of whether a process included participants.

Participatory decision methods enter applied praxis because practical knowledge and practical authority are rarely concentrated in the same position. A central institution can possess formal decision rights while lacking detailed knowledge of implementation conditions. Technical specialists can possess mechanism knowledge while having limited access to situated burdens. Affected subjects can possess direct knowledge of consequences while lacking recognized categories through which that knowledge can enter a formal process. Representatives can coordinate collective expression while remaining imperfectly connected to the positions they represent. Participatory methodology is therefore concerned with the architecture through which these differentiated positions become visible, communicable, comparable, and practically consequential.

Participation should also be understood as potentially generative. A participatory process can produce new information, new categories, new relationships, new trust or distrust, new collective capabilities, and new action possibilities. It can also alter expectations, redistribute authority, create procedural dependence, or stabilize particular representations of a problem. Participation is therefore not merely an input channel attached to a decision that was otherwise already constituted. In some settings it changes the practical field within which the decision itself is defined.

Table 11.14: Methodological components of participatory decision-making.

Component	Methodological object	Primary contribution	Characteristic concern
Stakeholder identification	Positions with consequential relations to praxis	Maps knowledge, authority, implementation, dependence, responsibility, and affectedness	Broad lists can obscure differences in standing and practical function
Affected subjects	Positions materially altered by the trajectory	Reveals burdens, benefits, risks, option changes, and situated consequences	Some affected positions are weakly visible or unable to participate directly
Deliberation	Structured exchange of reasons and interpretations	Tests claims, exposes disagreement, revises framing, and develops provisional orientation	Procedure, agenda, language, power, and time can shape what becomes discussable
Participatory mapping	Joint construction of relational representations	Adds local knowledge, alternative boundaries, hidden relations, and contested categories	A map can stabilize one representation and exclude relations that resist the chosen form
Co-design	Shared generation and revision of alternatives	Expands the action space and aligns design with situated capabilities and constraints	Nominal collaboration can preserve externally fixed goals or decision rights
Representation	Relations through which some positions speak or act for others	Extends participation where direct entry is difficult and supports continuity and aggregation	Mandate, feedback, internal diversity, and representational distance require governance
Voice	Pathways for claims, warnings, proposals, and dissent	Makes situated knowledge and judgment practically receivable	Expression can remain symbolic when uptake, protection, or response pathways are weak
Epistemic participation	Participation as knowledge-generating and field-transforming event	Generates evidence, categories, relations, and revised action possibilities	Observation and participation can change the field whose properties are being inferred
Contestability	Procedures for challenge, review, and reopening	Supports correction, alternative evidence, reason-giving, and revision	Contestation must be usable, protected, timely, and connected to consequences
Unequal participation	Distribution of participation capacity and burden	Diagnoses differential access, cost, risk, influence, and persistence	Equal invitation can coexist with unequal effective participation and unequal exposure

Definition 11.242 (Participatory decision method). A *participatory decision method* is a specified and revisable procedure through which affected subjects, stakeholders, representatives, experts, institutions, or other practically relevant positions contribute knowledge, interpretation, judgment, proposal, authorization, implementation, monitoring, contestation, or revision to a consequential decision process.

Definition 11.243 (Participation-method architecture). A *participation-method architecture* records the positions included in a participatory process, the practical functions assigned to them, the stages at which they enter, the forms through which they contribute, the authority attached to those contributions, the burdens and protections associated with participation, and the pathways through which disagreement can alter or reopen the process.

Table 11.14 summarizes the ten methodological components developed below. The table separates roles that are often compressed into a single vocabulary of stakeholder

engagement. Identification, affectedness analysis, deliberation, mapping, design, representation, voice, epistemic participation, contestability, and participation equality perform different functions. A process can be strong in one and weak in another. Methodological evaluation should therefore reconstruct the complete participation architecture rather than infer quality from the number of meetings, participants, comments, or represented organizations.

11.14.1 Stakeholder Identification

Stakeholder identification determines which positions enter the initial participatory frame and why. Its methodological role is not to create a flat inventory of everyone who might have an interest. It is to reconstruct materially relevant relations to the practical object. These relations can include affectedness, authority, knowledge, implementation capacity, dependency, resource control, maintenance responsibility, legal standing, representational role, or capacity to alter the trajectory through support, refusal, adaptation, or exit.

Definition 11.244 (Stakeholder identification profile). A *stakeholder identification profile* records each provisionally identified position, the relation through which it becomes practically relevant, the stage and horizon of that relevance, the form of knowledge or authority it may contribute, and the conditions under which its status should be revised.

The term *stakeholder* should therefore remain role-sensitive. A position that bears substantial risk differs from a position that supplies technical expertise. A regulator differs from a service provider. A group whose future options can be foreclosed differs from an actor with a commercial interest in implementation. Treating these relations as interchangeable can convert participation into a negotiation among recognized organizations while leaving consequence-bearing positions weakly represented.

Identification should also be recursive. Practical diagnosis, historical reconstruction, scenario analysis, monitoring, or participation itself can reveal positions that were omitted initially. A new relation can emerge during implementation. A group can become affected only after an institution changes its procedures. A future maintenance burden can create a stakeholder relation that was absent at the moment of authorization. Stakeholder identification is therefore a versioned practical map rather than a one-time administrative list.

The method can proceed through several complementary routes. Institutional records can identify formally recognized actors. Relation mapping can reveal dependency and authority. Historical analysis can reveal positions whose present exclusion results from earlier classifications. Local knowledge can disclose informal actors or intermediaries. Scenario construction can identify positions exposed only under adverse or long-horizon histories. These routes need not converge immediately. Their disagreement can itself indicate uncertainty about the practical boundary.

A stakeholder method should also distinguish practical relevance from representational convenience. Highly organized actors are easier to contact than dispersed or weakly institutionalized positions. Administrative visibility can therefore bias identification toward actors already legible to the institution. The method should record this possibility through a *stakeholder visibility gap*: a difference between practical relevance and the capacity of the current process to recognize and engage the relevant position.

Definition 11.245 (Stakeholder visibility gap). A *stakeholder visibility gap* is a material difference between a position's practical relevance to a decision trajectory and the degree to which that position is recognized, represented, or reachable within the current participation architecture.

Stakeholder identification consequently prepares, but does not settle, questions of standing. Inclusion in a stakeholder map does not automatically imply equal decision authority. Different practical relations can justify different forms of participation. The methodological task is first to make those relations explicit enough that later allocation of participation and authority can be examined rather than silently inherited from institutional convenience.

11.14.2 Affected Subjects

Affected-subject analysis gives methodological priority to positions whose conditions are materially altered by the practical trajectory. Chapter 10 defined affected subjects broadly in relation to capabilities, burdens, benefits, risks, rights, dependencies, environments, and future options. The present subsection operationalizes that category by asking how affectedness is identified prospectively, observed during implementation, and revised when previously unseen consequences emerge.

Definition 11.246 (Affected-subject tracing). *Affected-subject tracing* is a participatory and analytical method for identifying the positions whose conditions can be materially altered by an intervention, non-action, institutional arrangement, or evolving practical history, together with the pathways through which those effects arise.

Affected-subject tracing can begin from the anticipated consequence structure of the decision. Direct recipients are only one subset. The method should also examine relational propagation: suppliers, caregivers, neighboring institutions, maintenance actors, dependent populations, ecological relations, later users, or other positions can inherit consequences through channels not captured by the initial target definition. Scenario analysis can help identify such positions before commitment, while monitoring can reveal them afterward.

The method should preserve multiple dimensions of affectedness rather than using one magnitude score by default. Duration, reversibility, voluntariness, dependence, substitutability, exposure, recovery capacity, option loss, and distribution can all change the practical significance of an effect. A modest but irreversible loss of access can matter differently from a larger temporary inconvenience. A benefit that generates long-term dependence can require different analysis from a benefit that expands independent capability.

Direct participation can itself be difficult or impossible for some affected subjects. Future subjects cannot attend present deliberation. Some subjects may face language, disability, safety, mobility, legal-status, time, or economic barriers. Some practical objects include non-human living systems or diffuse ecological relations for which direct voice is unavailable. Under these conditions, affectedness should not disappear merely because conventional participation is impossible. Representation, guardianship, scenario analysis, ecological evidence, legal duties, institutional trusteeship, or other methods can provide partial access while making the absence of direct feedback explicit.

Affectedness can also be revealed through participation itself. A participant may describe a burden that the initial diagnostic categories did not contain. Recognition

of that burden can become an epistemic event that revises the problem representation, consequence map, or affected-subject boundary. The method should preserve a route from such disclosure to formal revision rather than treating it as anecdotal commentary outside the analytical frame.

Definition 11.247 (Affectedness revision trigger). An *affectedness revision trigger* is an observation, testimony, consequence, model result, or practical event that provides material reason to revise which positions are treated as affected, how affectedness is represented, or how participation and protection are allocated.

The resulting affected-subject map should be linked to later participation methods. Deliberation can test interpretations of consequence. Participatory mapping can reveal relational propagation. Co-design can alter how burdens are distributed. Representation and voice determine how affectedness enters collective judgment. Contestability provides a route when the formal process continues to misrecognize an affected position. Affected-subject analysis therefore functions as an organizing relation across the whole participatory architecture.

11.14.3 Deliberation

Deliberation is a structured method for exchanging reasons, interpretations, evidence, values, objections, and proposals under conditions where no single position possesses complete practical knowledge or uncontested authority. Its methodological contribution is broader than preference aggregation. Deliberation can reveal hidden assumptions, distinguish factual disagreement from value disagreement, expose divergent interpretations of risk, generate new alternatives, and revise the language through which the practical problem is described.

Definition 11.248 (Practical deliberation protocol). A *practical deliberation protocol* specifies the participants, agenda formation process, information access, forms of contribution, sequencing of discussion, facilitation and translation arrangements, decision relation, dissent recording, protection conditions, and revision pathways through which structured practical reasoning occurs.

The protocol matters because deliberation is itself an intervention into the field. Agenda order can shape salience. Technical framing can privilege some forms of knowledge. Time limits can favor participants already familiar with institutional language. Public settings can suppress contributions carrying social or professional risk. Early statements by high-status actors can change later expression. A deliberative method should therefore record relevant procedural choices rather than treating the conversation as an unstructured source of preferences.

Deliberation can serve different practical functions. It can be exploratory, seeking to identify concerns and categories. It can be interpretive, testing competing understandings. It can be generative, producing alternatives. It can be comparative, examining consequences among options. It can be authorizing, contributing to a collective commitment. It can be evaluative or revisional after implementation. These functions should be distinguished because the appropriate participant composition, information requirements, and decision consequences differ across them.

Disagreement should remain visible. A deliberative process need not convert plural values or interpretations into consensus. Forced convergence can erase material uncertainty or minority knowledge. The method should instead distinguish areas of convergence, structured disagreement, unresolved uncertainty, protected objections,

and questions requiring additional inquiry. A *deliberation record* can preserve these distinctions together with the reasons offered for provisional closure.

Definition 11.249 (Deliberation record). A *deliberation record* documents the materially relevant claims, reasons, evidence, disagreements, alternative formulations, proposed options, unresolved questions, and changes of position that emerged through a deliberative process, together with their relation to subsequent decision or revision.

Deliberation can also generate collective capability. Participants may develop a shared vocabulary, new trust relations, improved understanding of institutional constraints, or new capacity for coordinated action. Conversely, poorly governed deliberation can generate distrust, exhaustion, strategic polarization, or the impression of participation without influence. The methodological object is therefore both the content generated through discussion and the relational consequences of the deliberative process itself.

11.14.4 Participatory Mapping

Participatory mapping combines relational representation with situated knowledge. Participants contribute to the construction, correction, or interpretation of maps of actors, relations, resources, constraints, capacities, risks, histories, institutions, places, or action possibilities. The map can be spatial, network-based, processual, temporal, categorical, narrative, or hybrid. Its defining feature is that the represented field is constructed through structured contribution from positions that possess differentiated access to it.

Definition 11.250 (Participatory practical map). A *participatory practical map* is a revisable representation of a consequential field whose objects, relations, boundaries, labels, or interpretations are constructed or corrected through contributions from multiple situated positions.

Participatory mapping can reveal relations that centralized administrative data omit. Front-line participants can identify informal dependencies. Affected subjects can show where a formally available service becomes inaccessible. Local actors can identify timing, maintenance, trust, or mobility relations absent from a conventional network model. Historical participants can add events that explain present categories. Experts can contribute mechanism structure. The method therefore creates an interface among forms of access rather than presuming that one source contains the complete map.

Mapping should also record disagreement. Participants can differ over whether a relation exists, how strong it is, what it means, where a boundary lies, or which historical event matters. A single finalized map can conceal this disagreement. Where relevant, the method can preserve layered maps, alternative labels, uncertainty markers, provenance, or parallel representations. The objective is not graphical consensus for its own sake but a decision-relevant representation whose provenance and contestation remain visible.

The mapping process can itself become performative. Naming a relation can make it institutionally visible. Representing an informal actor can alter recognition or bargaining position. Drawing a boundary can create a category that later structures eligibility or responsibility. Mapping therefore belongs directly to the epistemic-event architecture of Section 11.4. A participatory practical map should record when the act of representation materially changes the field it depicts.

Definition 11.251 (Map provenance layer). A *map provenance layer* records which positions contributed particular objects, relations, labels, boundaries, confidence judgments, disagreements, or revisions to a participatory practical map and how those contributions were transformed during synthesis.

Participatory maps can interface with formal models without being reduced to them. A relational map can inform a network representation. A temporal event map can inform a partial-order or 2-complex model. A map of constraints and capacities can inform scenario construction. Yet the translation should preserve remainders where participants' categories, meanings, or uncertainties do not have a justified formal counterpart. This keeps participatory mapping consistent with the model-plurality discipline developed throughout Chapter 11.

11.14.5 Co-Design

Co-design concerns participatory generation and revision of practical alternatives. Its methodological significance follows directly from the evolving-action-space architecture of Section 11.7. If the existing action menu is historically produced and incomplete, participation need not be limited to evaluating alternatives defined elsewhere. Participants can contribute to generating new interventions, institutional arrangements, sequencing strategies, safeguards, interfaces, monitoring practices, or mechanisms of implementation.

Definition 11.252 (Practical co-design). *Practical co-design* is a structured participatory method through which multiple practically relevant positions jointly generate, specify, test, or revise elements of an action, intervention, institutional arrangement, or adaptive pathway.

The degree of co-design can vary. Participants can shape problem formulation, goals, design parameters, service interfaces, implementation rules, monitoring, or revision conditions. A process should therefore state which design objects are genuinely open. Inviting participants to choose colors, wording, or minor implementation details while goals, architecture, resource allocation, and authority remain fixed is methodologically different from allowing participants to reshape the intervention structure itself.

Co-design can generate options through recombination of differentiated knowledge. Technical actors can identify physical feasibility. Local actors can identify practical workarounds. Affected subjects can identify burdens or opportunities. Institutional actors can identify legal and procedural pathways. The resulting alternative can therefore be absent from any participant's initial option set. This is a direct example of participation generating the action space rather than merely evaluating it.

The method should also preserve design provenance. When an alternative emerges through a multi-actor process, later evaluation should be able to reconstruct which constraints, values, observations, and trade-offs shaped it. Otherwise the final design can appear as a technically given object, and the practical reasons for its form can disappear from institutional memory.

Definition 11.253 (Co-design provenance record). A *co-design provenance record* documents the practical positions, contributions, constraints, design changes, unresolved disagreements, and decision rights through which a co-designed alternative was generated and revised.

Co-design also changes participants. Repeated design work can build capability, shared vocabulary, trust, and implementation ownership. It can also consume time, create dependency on facilitation, expose internal disagreements, or shift responsibility toward participants who lack corresponding authority or resources. The method should therefore evaluate the generative consequences of the design process itself alongside the qualities of the resulting intervention.

11.14.6 Representation

Representation becomes necessary whenever affected or relevant positions cannot participate directly at every stage or scale. Participatory decision methodology should therefore specify how representatives are selected or recognized, what they are authorized to do, how they remain connected to represented positions, and how representational claims can be corrected. Representation is a relational method of extending practical presence, not a simple substitution of one actor for another.

Definition 11.254 (Representational method profile). A *representational method profile* records the represented positions, representative positions, basis of mandate, scope and duration of authorization, channels of feedback, internal diversity, accountability conditions, and mechanisms for revision or replacement.

Representation can arise through election, delegation, appointment, professional role, guardianship, legal standing, association, expertise, institutional mandate, or informal recognition. These forms carry different justificatory structures. A representative selected by a membership organization differs from an expert asked to infer the interests of future subjects. A community leader differs from an administrative category that claims to stand for a population. The method should document these differences rather than place them under one undifferentiated heading.

Representational adequacy is also stage-specific. A representative who can articulate broad concerns may be poorly positioned to evaluate technical implementation. A technical representative may possess strong domain knowledge while weakly reflecting internal value pluralism. Multiple representatives or layered representation can sometimes preserve differentiated functions more effectively than seeking one spokesperson for a heterogeneous position.

The method should monitor *representational drift*: divergence between the practical claims, priorities, or conditions of represented positions and the claims advanced by a representative over time. Drift can arise from changing circumstances, information asymmetry, professionalization, institutional incentives, weak feedback, or internal disagreement among represented subjects.

Definition 11.255 (Representational drift). *Representational drift* is a material divergence over time between the practical positions attributed to represented subjects and the positions articulated or enacted by those acting on their behalf, relative to the authorized representational relation.

Direct feedback can reduce drift where it is possible. Where represented subjects cannot provide feedback directly, the architecture should preserve alternative safeguards: plural representation, trusteeship duties, transparent assumptions, external review, scenario analysis, contestability, or periodic reconsideration of the representational basis. The objective is not perfect identity between representative and represented position, but a traceable and revisable relation whose limits remain visible.

11.14.7 Voice

Voice concerns the methodological pathway through which knowledge, experience, judgment, objection, proposal, warning, or dissent becomes practically receivable. Chapter 10 distinguished voice from participation and from influence. The applied methodological task is therefore to design and evaluate the chain from expression to reception and response rather than counting opportunities to speak.

Definition 11.256 (Voice-method pathway). A *voice-method pathway* is the organized sequence through which a participant or represented position can formulate a contribution, transmit it through an accessible channel, obtain translation or protection where needed, have it received by relevant decision positions, and connect it to a documented response, inquiry, or revision process.

Different forms of knowledge require different voice interfaces. Quantitative evidence can enter through formal reports. Operational knowledge can enter through incident logs or structured interviews. Lived experience can require narrative formats. Dissent can require confidential or protected channels. Local warnings can require rapid escalation rather than periodic consultation. A single participation interface can therefore systematically privilege the forms of expression it was designed to receive.

Voice methods should distinguish *expression capacity*, *transmission capacity*, *reception capacity*, and *response capacity*. Weakness in any one dimension can sever the pathway. A technically open comment period can still produce weak voice if submissions are not read by relevant actors, if institutional categories render them unintelligible, if retaliation is possible, or if no process exists for responding to material objections.

Voice also interacts with epistemic status. A participant's statement can be testimony, observation, interpretation, value judgment, warning, proposal, or strategic claim. The method should preserve these distinctions without requiring every contribution to imitate expert evidence. Different contributions can carry different inferential roles. A lived account can reveal an unrecognized burden without independently establishing a general causal mechanism. A technical model can estimate a mechanism without representing the practical meaning of its consequences.

A *voice uptake record* can preserve this relation between contribution and institutional response.

Definition 11.257 (Voice uptake record). A *voice uptake record* documents a materially relevant contribution, the position from which it originated, its practical and epistemic type, the pathway through which it was considered, the response or resulting inquiry, and any consequent change to the decision architecture.

This record helps distinguish reasoned non-adoption from symbolic consultation. A contribution need not determine the final decision to possess effective voice. It should, however, have a plausible and traceable route to consideration, response, investigation, or revision where its relevance warrants such treatment.

11.14.8 Participation as Epistemic Event

The revised GR epistemic architecture gives participation a stronger methodological role than information elicitation. A participatory encounter can generate an epistemic event when it changes how the practical field is observed, categorized, inter-

puted, or institutionally recognized. If that event is taken up by actors or institutions, it can also become performatively coupled to transformations of the field itself.

Definition 11.258 (Participatory epistemic event). A *participatory epistemic event* is an event arising through participatory praxis that materially changes a practical representation, category, evidential relation, recognized subject position, model, action space, or other epistemic condition relevant to subsequent decision or intervention.

A participatory epistemic event can take many forms. Testimony can reveal a previously unrecognized burden. Deliberation can distinguish two mechanisms that were previously conflated. Participatory mapping can reveal an informal dependency. Co-design can generate an alternative absent from the prior feasible set. Recognition of a group as affected can change standing or institutional obligations. A local warning can cause a model to be revised. These events do more than add another data point to an unchanged analysis.

The methodological challenge is to preserve the distinction between *readout* and *transformation*. Participation can first produce a representation: a map, statement, classification, or revised model. Its institutional uptake can then change the field by redistributing attention, authority, resources, rights, expectations, or action possibilities. The participation record should document both moments where they differ.

Definition 11.259 (Participatory epistemic coupling record). A *participatory epistemic coupling record* identifies a participatory event, the representation or knowledge change it produced, the mechanism through which that change entered practical uptake, and the resulting transformation, if any, of relations, institutions, subjects, capacities, constraints, models, or action spaces.

This structure also clarifies why participation can change history weights or transition potentials in model-specific form. A newly recognized constraint can reduce the accessibility of one proposed trajectory. Formation of trust can increase the practical reachability of a cooperative path. A new legal or institutional recognition can generate a branch that did not previously belong to the reachable action space. In a 2-complex or partially ordered representation, the participatory event can become a new vertex whose relational consequences alter later admissible extensions. These are optional computational realizations of a broader methodological point: participation can change the conditions under which later histories unfold.

The same generative capacity can create risk. Participation can stabilize an inaccurate category, expose participants to retaliation, create expectations that cannot be met, or reorganize bargaining relations in unintended ways. Participatory methods should therefore be evaluated as interventions with consequences, not only as neutral channels for collecting information.

Proposition 11.260 (Participation and practical evolution). *When a participatory process materially changes practical representations, recognized positions, relations, capacities, institutions, or reachable actions, participation belongs to the generative history of the decision field and should be documented as part of the intervention architecture rather than treated solely as prior consultation.*

11.14.9 Contestability

Contestability provides a methodological route for challenging practical representations, evidence, procedures, criteria, authority, implementation, or consequences af-

ter an initial participation process has produced provisional closure. It is therefore distinct from initial participation. A subject can have been included in deliberation and still require a later pathway to challenge the resulting decision when new evidence, changed conditions, or unaddressed disagreement emerges.

Definition 11.261 (Participatory contestability architecture). A *participatory contestability architecture* specifies the practical objects that can be challenged, the positions with standing to initiate challenge, the channels and evidentiary forms through which challenge can enter, the protection and review conditions attached to it, and the possible consequences for explanation, correction, remedy, revision, suspension, or reopening.

Contestability should be proportionate to the practical object. A technical parameter correction can require a different route from a challenge to the legitimacy of the problem formulation or the authority of the decision body. The architecture can therefore contain multiple levels: local correction, formal review, escalation, independent appeal, public challenge, or reopening of deliberation. Each level should specify what can change and who can authorize the change.

Usability matters. A formal appeal right can be practically weak if the process is costly, slow, inaccessible, risky, procedurally opaque, or disconnected from any power to alter the decision. Contestability should therefore be evaluated through an *effective contestability profile* containing access, cost, timeliness, protection, independence, reason-giving, remedy, and capacity to reopen materially relevant questions.

Contestability also supports epistemic correction. A challenge can reveal omitted evidence, a model failure, misclassification, changing affectedness, unanticipated harm, or representational drift. The contestation itself can therefore become an epistemic event. The method should preserve a trace from challenge to response so that institutional learning is possible even where the original decision remains in force.

A participation process organized around consensus can make contestability especially important. Consensus at one moment does not eliminate later disagreement or new consequences. Likewise, minority positions recorded during deliberation can become relevant if later events support their concerns. The contestability architecture should therefore connect to dissent records, monitoring, provenance, and the reopening conditions developed in Chapter 10.

Proposition 11.262 (Contestability and provisional closure). *Participatory decision methods support responsible provisional closure most strongly when materially relevant challenge can enter a protected, intelligible, and consequence-bearing review pathway after initial participation has ended.*

11.14.10 Unequal Participation

Participation capacity is distributed unevenly. Time, money, safety, language, literacy, technical expertise, institutional familiarity, social status, mobility, digital access, legal standing, organizational support, confidence, and prior experience can all affect whether a formally available participatory opportunity becomes practically usable. Methodological analysis should therefore distinguish equal invitation from equal effective capacity to participate.

Definition 11.263 (Participation-capacity profile). A *participation-capacity profile* records the resources, capabilities, protections, access conditions, interpretive sup-

port, time, persistence, and institutional relations that affect a position's practical ability to enter, remain in, influence, and withdraw from a participatory process.

Unequal participation can operate through several stages. Some positions are omitted before the process begins. Some can attend but cannot contribute in the dominant language or technical form. Some can contribute but possess little uptake. Some can influence one meeting but cannot sustain participation across a long process. Some bear substantial opportunity costs or risks for participation while others participate as part of paid professional roles. Some can threaten exit or mobilize external power while others cannot. These differences should not be collapsed into a single attendance statistic.

The method should therefore include a *participation burden profile*. Relevant burdens can include time, travel, care responsibilities, disclosure, translation effort, reputational or employment risk, exposure of sensitive knowledge, emotional labor, technical preparation, and repeated procedural engagement. Compensation, accessibility, scheduling, translation, confidentiality, childcare, technical assistance, protected channels, or other supports can alter these burdens, although no single support eliminates structural inequality by itself.

Definition 11.264 (Participation burden profile). A *participation burden profile* records the material, temporal, cognitive, social, emotional, legal, informational, and opportunity costs that different positions bear in order to enter and remain within a participatory process.

Unequal influence also requires separate analysis. A highly resourced actor can dominate agenda-setting without speaking more often. Technical expertise can shape the categories through which other contributions are interpreted. Institutional actors can control which proposals are considered feasible. Facilitators can influence sequencing and synthesis. Representatives can monopolize communication with decision-makers. A *participation influence profile* can therefore map practical leverage across stages rather than infer influence from visibility alone.

Corrective design should be relational rather than mechanical. Equal speaking time can be useful in some settings and counterproductive in others. Weighted representation, separate deliberative spaces, protected minority reports, capacity-building, compensation, independent facilitation, or staged processes can sometimes improve effective participation. Their appropriateness depends on the relevant asymmetry and practical object. Methodological transparency requires documenting why a particular correction was chosen and what inequalities remain unresolved.

Unequal participation also creates a justice problem that cannot be solved by procedural inclusion alone. A process can become more participatory while transferring substantial burdens of knowledge production, legitimacy, or implementation to less powerful subjects. Participation should not become a mechanism through which institutions externalize responsibility onto those already exposed to consequences. The architecture should preserve the distinction between contributing to a decision and acquiring responsibility for institutional capacities one does not control.

Definition 11.265 (Participation equity remainder). A *participation equity remainder* records material inequalities of access, burden, influence, representation, protection, or response capacity that remain after the participatory method has applied its feasible corrective measures.

Preserving this remainder supports later accountability and revision. A participa-

tory process can be the best available architecture under present constraints while still carrying unresolved inequalities. Recording them is preferable to representing procedural completion as equal agency.

Proposition 11.266 (Participatory method adequacy). *A participatory decision method is practically stronger when it makes relevant positions visible, preserves differentiated epistemic contributions, connects voice to uptake, distinguishes participation from authority, records representational and participation inequalities, treats participation as potentially generative, and maintains usable pathways for contestation and revision.*

Proposition 11.266 locates participation within the wider decision architecture developed in this chapter. Participation can revise diagnosis, goals, models, action spaces, scenarios, criteria, and institutional arrangements. It can also generate new practical relations and therefore change which interventions become feasible or legitimate. The next methodological question concerns where purposive intervention should be directed once these epistemic, participatory, and relational structures have been reconstructed. Section 297 therefore turns to intervention target selection across state variables, relations, historical-relational subjects, structures, constraints, capacities, institutions, observation regimes, fields, generative conditions, rules, and history or transition potentials.

11.15 Intervention Target Selection

Sections 11.2–11.14 developed practical diagnosis, goal and criterion specification, epistemic-event architecture, decision analysis, scenario construction, robustness, adaptation, optimization, formal and interpretive models, and participatory methods. The present section turns from reconstruction and comparison toward the methodological problem of *where* purposive intervention is directed. Its role within Chapter 11 is to distinguish target selection from the later questions of timing, scale, intervention depth, and mechanism design. Its objective is to provide a layered target architecture spanning state variables, relations, historical-relational subjects and entities, structures, constraints, capacities, institutions, observation and representation regimes, fields, generative conditions, rule-level objects, and history or transition potentials. The method is relational, historical, and model-plural: a target is specified relative to a practical diagnosis and a representation of the field, while target selection remains revisable when epistemic or practical events disclose that the intervention is acting on a different object from the one initially intended.

An intervention target is not simply the variable that a decision-maker wishes to change. Practical configurations can be transformed at several analytically distinct levels. A program can seek to alter an observable state while leaving the relations generating that state largely unchanged. It can alter a relation without changing the institutional rule through which the relation is reproduced. It can expand a capability while leaving the surrounding constraint configuration intact. It can change a classification or observation regime and thereby transform which subjects become visible, which actions become institutionally available, and which future histories receive practical support. It can act on a generative rule rather than on a present output. It can also alter the relative accessibility of future histories without determining one unique future state. Target selection therefore concerns the practical object to which

intervention is addressed and the consequences of choosing one target layer rather than another.

Definition 11.267 (Intervention target). An *intervention target* is a provisionally specified object, relation, configuration, process, condition, rule, representation, or history-generating feature toward which purposive practical transformation, preservation, activation, inhibition, or protection is directed.

Definition 11.268 (Target architecture). A *target architecture* records the selected intervention targets, their analytical levels, relations among targets, representation and measurement assumptions, expected generative relevance, affected positions, uncertainty, dependencies, and conditions under which the target specification should be revised.

Target selection should remain distinct from four adjacent methodological decisions. *Mechanism* concerns how an intervention is expected to alter the target or the field connected to it. *Depth* concerns how far into the generative architecture the intervention reaches. *Scale* concerns the spatial, relational, institutional, or historical resolution at which intervention is organized. *Timing and sequencing* concern when and in what order interventions occur. A relation can be the target at several different scales; an institution can be modified superficially or deeply; the same capacity target can be approached through multiple mechanisms; and an appropriate target can still fail if engaged at the wrong time. Sections 300–301 therefore develop these design problems separately after the target architecture has been established.

Table 11.15 summarizes the layered target architecture developed below. The layers are analytically distinguishable but practically coupled. An intervention aimed at a state variable can change relations; an institutional reform can alter observation regimes; a changed classification can transform subject standing; a capacity intervention can generate new actions; a rule-level intervention can reshape entire history families. Target selection should therefore specify both the *focal target* and the surrounding targets that are expected to move as consequences or enabling conditions.

Definition 11.269 (Focal and consequential targets). A *focal target* is the practical object toward which an intervention is primarily directed. A *consequential target* is another object expected to change materially because of the intervention even though it is not the principal object of purposive transformation.

This distinction prevents target descriptions from becoming artificially isolated. If a classification reform is the focal target and institutional standing changes as a consequence, both belong in the intervention record. If a capability program is the focal target but it predictably alters dependency relations, the relational consequence should be represented before implementation where possible. Target selection is therefore a mapping problem across a layered generative field rather than the identification of one independent variable.

11.15.1 State Variables

State-variable targets concern observable or modeled conditions that can be represented at a particular stage of the practical system. They are often the most operationally accessible intervention objects because they can be measured, monitored, and connected to explicit criteria. Examples in a domain-general vocabulary include resource levels, waiting times, participation rates, exposure measures, temperatures, inventories, response latency, observed prevalence, or another locally defined state

Table 11.15: Layered architecture of intervention targets in application-dominant praxis.

Target layer	Practical object	Characteristic intervention question	Characteristic risk
State variables	Observable or modeled configuration variables	Which present condition should be shifted, stabilized, bounded, or restored?	State improvement can leave the generating architecture unchanged
Relations	Dependencies, flows, authority, trust, communication, care, exposure	Which relation should be created, weakened, strengthened, redirected, or protected?	Pairwise targeting can miss higher-order or historical relational structure
Subjects	Historical-relational configurations possessing continuity and agency	Which capacities, standings, internal relations, or historical conditions of a subject are implicated?	Point-agent representations can erase constitutive history and internal structure
Structures	Recurrent topology, organization, hierarchy, or pattern	Which durable configuration reproduces the practical trajectory?	Structural labels can become vague if mechanisms and boundaries remain unspecified
Constraints	Conditions restricting reachability or admissibility	Which constraint should be relaxed, transformed, preserved, or made explicit?	Removing a constraint can also remove protection, coordination, or constitutive order
Capacities	Effective abilities to sense, decide, act, maintain, learn, repair, or revise	Which capability should be generated, sustained, distributed, or regenerated?	Temporary resource injection can be mistaken for durable capacity
Institutions	Mandates, rules, roles, routines, memory, authority, and interfaces	Which institutional arrangement should be redesigned, strengthened, or reconstituted?	Formal redesign can diverge from enacted institutional practice
Observation regimes	Categories, indicators, records, classifications, models, and visibility rules	Which epistemic interface should be changed so that the field is observed differently?	Observation can become performative, exclusionary, or strategically manipulated
Fields	Distributed conditions affecting local possibilities and interactions	Which distributed influence, opportunity, exposure, or constraint pattern should change?	Field abstractions can obscure local heterogeneity and boundary dependence
Generative conditions	Conditions enabling or suppressing later valued generation	Which conditions shape the production of future capacities, relations, and possibilities?	Generativity can be expanded for some positions while narrowed for others
Rules	Transformation laws, permissions, composition rules, or update regimes	Which rule governing evolution or admissible transformation should be revised?	Rule change can propagate widely and generate difficult-to-reverse consequences
History potentials	Weights, accessibility, or transition structure across admissible histories	Which future pathways should become more or less reachable without fixing one outcome?	Weight semantics can be overinterpreted or confused with probability

descriptor. Their methodological usefulness lies in making a desired change sufficiently specific to organize action and evaluation.

A state variable should nevertheless be treated as a representation of a practical condition rather than the condition in its entirety. Section 11.12 established that state

construction depends on a model boundary, measurement mapping, temporal resolution, and interpretive scope. Targeting a measured state can therefore improve the indicator while leaving the relations or mechanisms that generate the state unchanged. An intervention that reduces a backlog by temporarily adding extraordinary personnel, for example, changes the state while potentially leaving institutional capacity, workflow relations, or generative bottlenecks intact. The state can later return toward its earlier configuration once the temporary input disappears.

Definition 11.270 (State-target profile). A *state-target profile* records the state variable or state representation selected for intervention, its measurement and boundary assumptions, the desired direction or admissible region of change, its relation to underlying generative mechanisms, and the conditions under which improvement in the represented state would be insufficient evidence of practical improvement.

State targeting can be appropriate when the practical objective is genuinely state-like. Emergency stabilization, restoration of a minimum stock, reduction of acute exposure, or maintenance of a bounded operating condition can require direct state intervention even when deeper mechanisms remain only partly understood. The important methodological discipline is to specify whether the state change is intended as stabilization, symptom relief, protective buffering, diagnostic probe, or durable transformation. These purposes imply different expectations about persistence and different requirements for complementary targets.

State targets can also possess threshold structure without reducing the entire intervention architecture to threshold logic. A safety variable may need to remain within an admissible interval. A service-level variable can trigger escalation when it crosses a locally justified boundary. Such thresholds are legitimate when their provenance and semantics are explicit. They do not establish that every practical target can be represented through one scalar state or that crossing the threshold identifies the complete intervention response.

State targeting should therefore be accompanied by a *state-generation question*: which relations, capacities, institutions, fields, or rules produce and reproduce the targeted state? The answer can remain provisional, but asking the question prevents operational convenience from being mistaken for generative explanation.

11.15.2 Relations

Relational targets concern the connections through which practical configurations are constituted and transformed. Relevant relations can include dependency, authority, trust, communication, care, exchange, exposure, coordination, recognition, representation, obligation, maintenance, or access. An intervention can seek to establish a missing relation, weaken an exploitative dependency, strengthen a fragile coordination link, redirect a flow, protect a care relation, rebalance authority, or create a new interface among previously disconnected positions.

Definition 11.271 (Relational intervention target). A *relational intervention target* is a specified relation or relational configuration whose existence, direction, intensity, quality, accessibility, composition, or governance is selected for purposive practical change.

Relation targeting differs from changing attributes of the positions connected by the relation. Two positions can retain similar individual capabilities while their dependency changes substantially. Conversely, training both positions can leave a dys-

functional authority relation untouched. This is why actor-level or state-variable interventions do not automatically produce relational transformation.

Relational targets should also preserve multiplicity. The same pair of positions can be connected simultaneously through trust, authority, information, resource dependence, contractual obligation, friendship, or exposure. Strengthening one relation can weaken or distort another. A centralized information interface can improve coordination while increasing surveillance dependence. A new contractual relation can improve formal accountability while weakening informal cooperation. A *relational target profile* should therefore record the type of relation being targeted and the adjacent relations likely to change.

Higher-order relations require particular care. Some practical configurations cannot be decomposed adequately into pairwise ties. A committee rule, shared infrastructure, multi-party coordination protocol, or collective norm can depend on interactions among several positions simultaneously. Section 11.12 introduced higher-order representations for such cases. Target selection should use them where pairwise simplification would erase the mechanism through which the intervention is expected to work.

A relation can itself have history. Trust generated through repeated interaction differs from a formally imposed coordination relation even when a present network diagram represents both as edges. Relational intervention should therefore ask how the relation was produced, what maintains it, what expectations it carries, and what would be lost if it were replaced. This historical dimension becomes especially important when the target relation contributes to the continuity of the subjects connected through it.

Proposition 11.272 (Relational target adequacy). *Relational targeting is practically stronger when the selected relation is typed, historically situated, connected to adjacent and higher-order relations, and linked to a plausible account of how its transformation changes later practical possibilities.*

11.15.3 Historical-Relational Subjects and Entities

Some interventions are directed toward subjects or entities whose practical identity cannot be reduced to a point state. Earlier sections established that a subject can be modeled as a historical-relational object: a configuration whose continuity depends on events, internal relations, external relations, capacities, classifications, institutional positions, memories, and commitments accumulated through time. Target selection should preserve this structure when intervention is expected to change the subject itself rather than merely one measured attribute.

A historical-relational subject target can concern capability formation, legal or institutional standing, internal coordination, memory, recognized identity, relation to other actors, or the conditions through which the subject maintains continuity. Examples include strengthening a collective's capacity for self-governance, restoring an organization's institutional memory, changing the standing of an affected group, supporting recovery of a damaged relational identity, or reorganizing an entity whose internal structure generates repeated failure. These are not well represented by treating the subject as one scalar variable.

Where a formal representation is useful, a subject can be represented schematically by a finite labeled historical-relational structure. Equation 11.34 gives one op-

tional representation.

$$\mathcal{C}_s = (V_s, E_s, F_s, \preceq_s, \lambda_s). \quad (11.34)$$

In Equation 11.34, vertices can represent events or states, edges can represent typed relations or transitions, faces can represent higher-order composition, $\preceq_s$ can encode partial historical precedence, and λ_s can provide model-specific labels. A labeled 2-complex is one possible realization of this structure. Narrative, institutional, network, dynamical, or agent-based representations remain equally admissible when they better fit the practical object.

Definition 11.273 (Subject-target boundary). A *subject-target boundary* specifies which internal events, relations, capacities, institutional positions, external interfaces, and historical conditions are included in the intervention representation of a subject or entity and which remain outside the current target model.

This boundary matters normatively and practically. Intervention directed at a person, community, organization, or collective can become overly individualizing if it locates a practical problem inside the subject while omitting the relations and institutions that generate the condition. The opposite error is also possible: an intervention can treat subjects only as positions in a structure and neglect internal capability, memory, meaning, or agency. Historical-relational targeting seeks to retain both the subject's internal organization and the external relations through which that organization is constituted.

Subject targeting should also distinguish transformation from replacement. If an intervention reorganizes internal relations so extensively that the later entity has different continuity conditions, governance, membership, or identity, the practical question can exceed ordinary capability enhancement. Target selection should record this possibility before later sections determine intervention depth and legitimacy.

11.15.4 Structures

Structural targets concern recurrent configurations that organize many local relations or trajectories. A structure can be represented through hierarchy, topology, role distribution, repeated dependency, segmentation, institutional layering, resource concentration, network architecture, categorical ordering, or another durable pattern whose effects cannot be attributed adequately to one local relation. Structural targeting therefore asks which configuration repeatedly reproduces the practical condition across cases, positions, or time.

Definition 11.274 (Structural intervention target). A *structural intervention target* is a recurrent relational or organizational configuration whose topology, ordering, distribution, interface pattern, or reproduction mechanism is selected for purposive transformation.

The term *structure* should not function as a substitute for mechanism. A diagnosis that identifies a problem as “structural” remains methodologically incomplete until it specifies what pattern is being referred to and how that pattern constrains or generates later possibilities. A hierarchy can reproduce unequal authority through role rules. A network can concentrate dependency around a central node. A classification architecture can repeatedly exclude positions whose attributes do not fit its categories. These are different structures and require different interventions.

Structural targets often interact with local adaptation. Actors can compensate for a problematic structure through workarounds, informal relations, or exceptional effort. Directly removing those compensations without altering the structure can worsen outcomes. Conversely, local adaptation can conceal structural failure and make the structure appear more functional than it is. Target selection should therefore distinguish *structure-maintaining adaptation* from *structure-transforming adaptation*.

A structural intervention can also redistribute fragility. Decentralizing one coordination structure can reduce concentration risk while increasing interface complexity. Centralizing a fragmented process can improve consistency while creating a single point of failure. Structural evaluation should therefore connect to the robustness, scale, and institutional analyses developed elsewhere in the chapter.

Definition 11.275 (Structural reproduction profile). A *structural reproduction profile* records the relations, rules, resources, routines, expectations, and feedback processes through which a targeted structure is maintained or regenerated across relevant positions and time horizons.

This profile helps determine whether a proposed intervention actually reaches the structure or merely alters one manifestation of it. It also prepares the later distinction between structural intervention and rule-level intervention: some structures can change while formal rules remain constant, while others are reproduced precisely through the rules that define admissible transformations.

11.15.5 Constraints

Constraint targets concern conditions that limit reachable actions, transitions, participation, or outcomes. Section 11.2 distinguished hard, soft, and contingent constraints during diagnosis, while Section 11.12 treats technical, institutional, protective, and constitutive constraints as possible inputs to formal optimization and search. Intervention target selection now asks which constraint should be relaxed, transformed, preserved, redistributed, or made explicit in order to change the practical trajectory.

Definition 11.276 (Constraint target profile). A *constraint target profile* records the selected constraint, the positions and actions it restricts, its practical function, modifiability, dependencies, protective or constitutive role where relevant, and the expected consequences of weakening, strengthening, relocating, or redesigning it.

A constraint should not be presumed undesirable merely because it limits action. Safety requirements, rights, ecological boundaries, separation of powers, review procedures, and professional standards can restrict immediate flexibility while preserving other values or long-horizon capacities. The intervention question can therefore be whether the constraint is mislocated, excessively rigid, poorly calibrated, asymmetrically imposed, or disconnected from the practical object it is intended to protect.

Constraints can also be relationally distributed. The same formal requirement can impose very different practical restrictions on actors with different resources, language access, institutional familiarity, mobility, or technological capability. Removing the formal constraint can improve reachability for one position while exposing another to greater risk. Constraint targeting should therefore include a *constraint incidence profile* showing who bears the restriction, who benefits from it, and who possesses capacity to navigate or modify it.

Some constraints interact multiplicatively. A small language barrier, scheduling difficulty, procedural requirement, and mobility limitation can jointly foreclose participation even when no single factor appears decisive. Intervention can therefore target a *constraint configuration* rather than one isolated restriction. This relational treatment is especially important when practical exclusion emerges from several weak constraints whose combination closes an action pathway.

Constraint transformation can generate new possibilities and new risks simultaneously. Relaxing an institutional permission rule can enlarge the action space while weakening accountability. Removing a technical bottleneck can increase throughput while overloading maintenance capacity. The constraint target should therefore remain connected to the later action-space and history-space consequences of its modification.

11.15.6 Capacities

Capacity targets concern effective abilities to sense, interpret, decide, coordinate, act, maintain, learn, repair, adapt, contest, or revise. A capacity is not identical to possession of resources. Resources become capacity only through activation pathways involving knowledge, authority, organization, access, time, relations, infrastructure, and institutional support. Target selection should therefore identify which capability is practically absent or fragile and which conditions allow it to become usable and durable.

Definition 11.277 (Capacity intervention target). A *capacity intervention target* is an effective practical ability, or a configuration of complementary abilities, selected for generation, strengthening, distribution, preservation, regeneration, or recovery.

Capacity interventions can operate at several levels. An individual can acquire skill. A team can develop coordination routines. An institution can develop monitoring or repair capability. A community can develop collective organization. A system can acquire redundancy, memory, or capacity to generate new options. These targets are related but not interchangeable. Training individuals does not automatically produce institutional capacity; acquiring infrastructure does not automatically produce maintenance capability; formal authority does not automatically generate implementation capacity.

Target selection should therefore distinguish *capacity stock*, *capacity activation*, and *capacity regeneration*. A stock is an available resource or competence. Activation concerns whether it can be mobilized in the practical situation. Regeneration concerns whether the capacity can be maintained, reproduced, transferred, or rebuilt after use or disruption. An intervention can create strong short-term activation while weakening regeneration through burnout, dependency on exceptional actors, or depletion of reserves.

Definition 11.278 (Capacity-generativity profile). A *capacity-generativity profile* records how a targeted capacity is produced, activated, maintained, transmitted, regenerated, and connected to the generation of later practical possibilities.

Capacity targeting is especially important when the present action space is inadequate. Section 11.10 established action-space regeneration as a core adaptive method. Generating a new action often requires generating the capacity to perform it. In such cases, capacity is not merely an enabling condition attached to an intervention; it is the focal intervention target through which a new practical branch becomes reach-

able.

Capacity distribution also matters. Concentrating technical capability in one institution can improve immediate performance while increasing dependency and weakening distributed resilience. Distributing capability can increase redundancy and local agency while generating coordination costs. Target selection should therefore record whose capacity is being strengthened and how that change modifies relations of dependence, authority, and future option generation.

11.15.7 Institutions

Institutional targets concern the durable arrangements through which mandates, authority, roles, routines, records, resources, expectations, accountability, and interfaces organize collective praxis. Chapter 10 developed institutions as generative media rather than passive containers. Intervention target selection therefore asks which institutional function, relation, memory system, coordination interface, mandate, accountability pathway, or revision mechanism should be transformed.

Definition 11.279 (Institutional intervention target). An *institutional intervention target* is a specified element or configuration of institutional mandate, authority, role, routine, memory, resource arrangement, interface, accountability relation, or self-revision capacity selected for purposive practical change.

Institutional targeting should distinguish formal design from enacted configuration. A written rule can remain unchanged while front-line routines, informal coordination, interpretation, or practical authority shift substantially. Conversely, a formal reform can produce little practical change when the organization lacks capability, memory, trust, or implementation pathways. An institutional target profile should therefore contain both the formal object and the enacted mechanism through which the institution currently operates.

Institutional memory can itself be the target. A recurring failure can persist because reasons, warnings, or prior experiments disappear across personnel transitions. A handoff protocol, provenance system, durable review role, or archival interface can therefore be an intervention directed at memory rather than at the substantive decision itself. Likewise, self-revision capacity can be targeted when an institution repeatedly encounters new conditions but lacks authority or procedure to alter its own rules.

Institutional interventions often redistribute power. Changing who can authorize action, who can access records, who can initiate review, or who can define categories modifies practical power even when the intervention is described procedurally. Target selection should therefore connect institutional targets to the power, participation, responsibility, and justice architectures developed in Chapter 10.

A practical institution also operates through interfaces with other institutions. Many failures occur between organizations whose internal procedures are individually competent. Target selection can therefore focus on an *institutional interface*: the protocol, data relation, responsibility boundary, escalation route, or coordination mechanism through which two institutional configurations interact. Interface targeting is often more precise than treating either organization as a unitary target.

11.15.8 Observation and Representation Regimes

Observation and representation regimes become intervention targets when practical trajectories are materially shaped by what can be seen, recorded, classified, measured, modeled, or institutionally recognized. The revised epistemic architecture of Section 11.4 distinguishes observation as readout from transformation while allowing epistemic events to become performatively coupled to changes in the field. Intervention can therefore be directed toward the epistemic interface itself.

Definition 11.280 (Observation-regime target). An *observation-regime target* is a specified element of the categories, indicators, measurement procedures, records, classification systems, models, reporting channels, visibility rules, or interpretive conventions through which a practical field becomes observable and actionable.

Changing an observation regime can alter what becomes legible. A new category can reveal a previously aggregated burden. A different temporal resolution can expose cyclical failure hidden by annual averages. Participatory monitoring can reveal local variation. A new reporting channel can make weak signals visible before they become system-level failures. These interventions change epistemic access even before any downstream decision changes.

Observation-regime intervention can also be performative. Once a category determines eligibility, a metric becomes a target, a rating affects resource allocation, or a classification changes legal standing, the representation participates in the practical field it describes. The intervention therefore needs both an epistemic and a relational consequence profile. Improving measurement precision can still produce harmful effects if the measure concentrates surveillance, creates strategic gaming, excludes unclassifiable positions, or transfers interpretive authority away from affected subjects.

Definition 11.281 (Representational intervention profile). A *representational intervention profile* records the representation being changed, the practical objects newly included or excluded, the epistemic gain sought, the positions controlling the representation, expected performative effects, strategic response risks, and conditions for revision or retirement of the representation.

Observation and representation targets can also include the model family itself. A practical system repeatedly analyzed through one model can develop blind spots that are not solved by adding more data to the same representation. Introducing an alternative model, preserving incompatible representations in parallel, or changing the mapping between observations and models can therefore be a legitimate intervention. This is especially relevant when model disagreement reveals omitted actors, scales, mechanisms, or histories.

Because observation can change behavior, intervention design should avoid the fiction that monitoring is always external to the system. Section 303 later develops monitoring methodology in detail. The present section establishes the prior target-selection question: whether the observation regime itself is one of the objects that needs purposive change.

11.15.9 Fields

Field targets concern distributed conditions that influence local possibilities, interactions, or transformations across a practical domain. A field representation can capture variation in opportunity, constraint, information, trust, exposure, institutional

influence, accessibility, or another quantity whose local value depends on a broader relational configuration. Field targeting is useful when no single actor or relation adequately represents the distributed condition the intervention seeks to alter.

Definition 11.282 (Field intervention target). A *field intervention target* is a distributed practical condition, represented over a specified relational, spatial, institutional, or historical carrier domain, whose local values, gradients, couplings, boundary conditions, or evolution are selected for purposive change.

A field target requires explicit semantics. The carrier domain, units or categories, locality relation, boundary conditions, coupling assumptions, and observation mapping should be stated. Otherwise field language can become a metaphor that names widespread influence without specifying what is distributed or how local change is connected to the broader configuration.

Where a formal field representation is useful, a field φ_t can parameterize local transformation conditions. Equation 11.35 provides a schematic intervention representation.

$$\varphi_{t+1} = \Psi_t(\varphi_t; au_t, e_t, \omega_t), \quad (11.35)$$

In Equation 11.35, τ_t denotes a model-specific intervention directed toward the field, while e_t permits epistemic events to affect the update where the model represents such coupling. The equation does not prescribe one physical interpretation of φ_t ; the field semantics remain specific to the practical model.

Field intervention can operate through local actions whose effects propagate, through changes to boundary conditions, through distributed infrastructure, or through modification of coupling among local positions. The same field can also respond unevenly because local capacities, institutions, or histories differ. Target selection should therefore avoid assuming spatial or relational homogeneity merely because the representation uses one field variable.

Field targeting also creates a scale question that Section 299 will address directly. A field can be represented at several resolutions, and a local intervention may appear negligible at one scale while substantially changing a critical interface at another. The target architecture should preserve enough resolution to identify where field transformation becomes practically consequential.

11.15.10 Generative Conditions

Generative-condition targets concern the conditions under which later capacities, relations, institutions, values, knowledge, actions, or other practically relevant possibilities can emerge and persist. Their importance follows directly from the generative orientation of GR. An intervention can be valuable because it creates a desired immediate state, but it can also be valuable because it changes the conditions under which future actors can generate, revise, or sustain valued possibilities themselves.

Definition 11.283 (Generative-condition target). A *generative-condition target* is a condition, relation, resource configuration, institutional arrangement, epistemic interface, or capability whose practical significance lies materially in how it enables, suppresses, redirects, sustains, or regenerates later processes of generation.

Generative conditions differ from ordinary intermediate variables because their

analytical role is explicitly future-producing. Trust can enable later coordination. Educational or technical capability can generate later action alternatives. Institutional memory can enable later error correction. Open standards can enable recombination. Safe participation channels can generate future knowledge. Repair capacity can preserve future reversibility. These conditions can be targeted even when their immediate output contribution is difficult to summarize in one metric.

A generative-condition intervention should distinguish *generation for whom* and *generation of what*. A system can become more generative for a central institution while reducing the ability of peripheral actors to initiate action. A platform can increase total innovation while concentrating control over access. An institution can generate more information while decreasing interpretive autonomy. Generativity is therefore not automatically normatively positive; its distribution and governance remain part of the target architecture.

Definition 11.284 (Generative-target incidence profile). A *generative-target incidence profile* records which positions gain or lose capacities for later generation, which objects or processes become easier or harder to generate, which dependencies mediate that change, and which future options are created, preserved, transformed, or foreclosed.

Generative-condition targeting can also be indirect. An intervention can protect a condition rather than maximize it. Maintaining diversity, preserving institutional slack, sustaining multiple knowledge traditions, or retaining repair capacity can protect the field's ability to respond to futures that cannot yet be specified. Such interventions connect directly to generative robustness from Section 11.9.

This target layer will become especially important when the book later returns to substantive GRE. Economic allocation, value transmission, institutional design, and productive capability can all be analyzed partly through the generative conditions they create or destroy. The present section keeps the concept domain-general so that later economic chapters can specialize it without altering its general praxis architecture.

11.15.11 Rule-Level Targets

Rule-level targets concern the transformation rules, permissions, update procedures, composition structures, or admissibility conditions through which the practical configuration evolves. They are deeper than changing one present state because they alter how future states or histories are generated from current conditions. A rule-level intervention can modify who is permitted to act, how decisions are composed, how resources are assigned, how categories update, how institutional responsibilities transfer, or how local transformations interact.

Definition 11.285 (Rule-level intervention target). A *rule-level intervention target* is a specified transformation rule, permission structure, composition law, update regime, or admissibility condition whose revision changes how subsequent practical configurations or histories can be generated.

A simple schematic distinction can be made between intervention within a rule and intervention on the rule. Equation 11.36 represents the latter.

$$F_{t+1} = \mathcal{T}_t(F_t; \tau_t, e_t, \omega_t). \quad (11.36)$$

In Equation 11.36, F_t denotes a model-specific rule or family of transformations governing evolution, and $\mathcal{T}_t$ denotes a higher-level transformation that changes that rule. The expression is intentionally general. In one model F_t can be a transition law; in another it can be an institutional update procedure, operator family, governance rule, or algorithmic policy.

Rule-level interventions can have broad consequences because they alter many later transitions rather than one local outcome. They can also create path dependence: once actors, institutions, or infrastructures adapt to a new rule, restoring the old rule may not restore the earlier field. Rule targeting therefore requires especially careful treatment of reversibility, transition management, monitoring, and responsibility.

Rule-level intervention also interacts with power. The capacity to define the rule governing others' actions can be more consequential than the capacity to choose within that rule. An institution that sets eligibility, classification, authorization, or update procedures can shape action spaces for positions that never participate directly in the rule-making process. Target selection should therefore identify who controls rule revision and who bears its downstream consequences.

Some apparent rule failures are actually implementation or capacity failures. Rewriting a rule when the problem is lack of coordination, maintenance, information, or enforcement can increase complexity without changing practical behavior. Conversely, repeated local exceptions can indicate that the rule itself no longer fits the field. Rule-level targeting should therefore be supported by diagnostic evidence that distinguishes the rule from the capacities and relations through which it is enacted.

11.15.12 History and Transition Potentials

The final target layer concerns the relative accessibility, plausibility, propensity, or other model-specific weighting of future histories. The revised GR architecture developed in Sections 11.4–11.10 allows practical evolution to be represented through families of admissible histories whose weights or transition potentials can change after epistemic events, interventions, subject transformations, or institutional change. Intervention need not therefore be represented only as movement toward one target state. It can be directed toward changing which future histories become easier, harder, newly admissible, or effectively foreclosed.

Definition 11.286 (History-potential target). A *history-potential target* is a model-specific feature of the admissible-history or transition architecture selected for change because it affects the relative accessibility, support, propensity, plausibility, or reachability of subsequent histories.

For a nonnegative history-weight representation, an intervention can be modeled schematically as a transformation of a weight functional. Equation 11.37 gives one general form.

$$W_{t+1} = \mathcal{Q}_t[W_t; \tau_t, e_t, \omega_t]. \quad (11.37)$$

In Equation 11.37, the semantics of W_t must be stated by the model. It can represent probability where normalized stochastic semantics are justified, or another non-negative quantity such as accessibility, plausibility, transition propensity, empirical

frequency, or simulation mass. The target is the represented distribution or ordering of future pathways, not a metaphysical potential assumed to exist independently of the model.

History-potential targeting can occur through many practical means. An early warning system can increase the accessibility of protective histories by enabling faster response. Capability building can make previously latent intervention branches reachable. Legal reform can open institutional pathways. A credible sanction can make some harmful trajectories less attractive to strategic actors. Investment in repair capacity can increase the accessibility of recovery histories after disruption. Participatory recognition can generate new collective pathways that did not previously belong to the effective action space.

The intervention can also change the history space itself. Equation 11.37 represents reweighting only where the relevant histories remain represented. A stronger transformation can create new branches, remove branches, alter event order, change composition rules, or transform the subject whose future is being represented. Target selection should therefore distinguish *history reweighting* from *history-space transformation*.

Definition 11.287 (History-space transformation target). A *history-space transformation target* is a practical object whose transformation is intended to create, remove, merge, separate, reorder, or otherwise change the admissible family of represented future histories rather than merely change weights over a fixed family.

A 2-complex or partial-order model can represent such intervention by changing admissible extensions, incidence relations, labels, or precedence constraints. An operator model can change the transformation family available at a stage. An agent-based model can generate new rules or capabilities. A narrative or institutional model can represent the same practical transformation without numerical weights. No single computational language is privileged.

Amplitude-like models remain an optional stronger specialization. If a model assigns complex amplitudes to histories, the intervention target can concern amplitude structure only after the model supplies explicit semantics for composition, phase, observation, and empirical interpretation. The presence of a 2-complex or ordered event structure is not sufficient to justify amplitude semantics. The general target architecture therefore remains expressed through admissible histories, transition structure, and explicitly interpreted weights or potentials.

History-potential targeting also raises a justice question. Making one future more accessible can make another less accessible, and the relevant histories can differ across affected positions. An intervention that increases aggregate probability of system stability can simultaneously narrow exit, autonomy, or future option space for a particular group. Target selection should therefore record whose future pathways are being widened, narrowed, protected, or foreclosed.

Definition 11.288 (Target-coupling record). A *target-coupling record* documents the focal intervention target, consequential targets, expected direction of change, represented mechanism of coupling among target layers, affected positions, uncertainty, possible history-space effects, and the observations that would trigger revision of the target architecture.

The target-coupling record provides the integrative output of this section. A practical intervention rarely changes only one layer. State, relation, subject, structure,

constraint, capacity, institution, observation regime, field, generative condition, rule, and history architecture can interact. The methodological task is therefore to select a focal target while preserving a sufficiently explicit representation of the coupled objects through which intervention can propagate.

Proposition 11.289 (Layered target-selection principle). *Intervention target selection is practically stronger when the focal target is distinguished from consequential targets, located within a layered historical-relational architecture, connected to a plausible generative pathway, assessed for distributional and epistemic effects, and revised when observation or implementation shows that the intervention is acting on a different practical object from the one originally specified.*

Proposition 11.289 completes the target-selection stage without yet determining when, where, or how deeply intervention should occur. The same target can be appropriate at one temporal window and inaccessible at another; two valid targets can require a particular order; and intervention can change the field so that a later target becomes reachable only after an earlier one has been transformed. The next section therefore turns from target architecture to the temporal architecture of intervention through timing, windows of possibility, critical junctures, event order, generative precedence, and adaptive sequencing.

11.16 Timing and Sequencing

Intervention target selection specifies what part of a practical configuration is intended to change. Timing and sequencing specify how intervention events are situated within an ordered practical history, which events or conditions precede others, which events remain unordered, and how later transformations become reachable through earlier ones. The role of this section is to develop the temporal architecture of intervention design before scale and depth are selected in Sections 299 and 298. The discussion proceeds from intervention timing and windows of possibility to critical junctures, generative precedence, order-sensitive operator composition, temporal coordination, delayed effects, staged intervention, and adaptive sequencing. The method is relational and dynamical. Within the present GR framework, historical time is represented primarily through order relations among events rather than by presuming a universal external clock. Calendar dates, durations, and continuous-time parameters remain available as model-specific labels or embeddings when they are useful.

Definition 11.290 (Event-ordered practical time). *An event-ordered practical time is a model-specific temporal structure*

$$\mathcal{T}^{(m)} = \left(\mathcal{E}^{(m)}, \preceq^{(m)}, \lambda^{(m)} \right), \quad (11.38)$$

in which $\mathcal{E}^{(m)}$ is a set of practical, epistemic, institutional, or other modeled events, $\preceq^{(m)}$ is a partial order encoding the precedence relations represented as temporally or generatively relevant, and $\lambda^{(m)}$ contains optional event labels such as actor, location, institutional role, clock date, duration, or other model-specific information. Events that are incomparable under $\preceq^{(m)}$ are left unordered by the model rather than being forced into a total temporal sequence.

Equation 11.38 provides the primary temporal representation used in this section.

The partial order can represent causal, generative, institutional, or procedural precedence according to the model. An order-compatible clock-time map $\tau : \mathcal{E}^{(m)} \rightarrow \mathbb{R}$ can be added when useful, but τ functions as a coordinate or label rather than as the definition of historical time itself. Where such an embedding is used, $e_i \prec e_j$ normally constrains the admissible clock ordering, while incomparable events need not be interpreted as simultaneous. A labeled 2-complex can provide a richer representation when events, relations, and higher-order composition need to be preserved together.

For an event $e \in \mathcal{E}^{(m)}$, its represented historical past and future can be written as Equation 11.39.

$$\downarrow e = \{e' \in \mathcal{E}^{(m)} : e' \preceq e\}, \quad \uparrow e = \{e' \in \mathcal{E}^{(m)} : e \preceq e'\}. \quad (11.39)$$

Equation 11.39 makes explicit that practical history can be reconstructed through event ancestry and admissible continuation rather than only through scalar time differences.

Definition 11.291 (Temporal intervention architecture). A *temporal intervention architecture* records the event-order structure, timing labels where relevant, precedence and concurrency relations, coordination requirements, expected delays, stage boundaries, review conditions, and adaptive resequencing rules through which one or more interventions are organized across a practical history.

Timing matters because the same intervention target can have different consequences under different relational conditions. A capacity-building programme introduced before responsibility is delegated can support later autonomy; the same programme introduced after dependency has become entrenched may operate as repair. A new observation regime introduced before authorization can inform design; introduced after implementation, it may mainly document consequences. An intervention can therefore be well targeted and still perform poorly because its temporal relation to enabling conditions, epistemic events, institutional readiness, or irreversible processes is mis-specified.

Table 11.16 summarizes the temporal dimensions developed in this section. The dimensions are analytically distinct but practically coupled. A critical juncture can create a window of possibility; a staged intervention can preserve a window while generating evidence; delayed effects can alter the appropriate sequence; adaptive sequencing can reorder later stages after a performative epistemic event changes the field.

11.16.1 Intervention Timing

Intervention timing concerns the placement of a contemplated intervention event within the ordered practical history in which it will operate. A timing decision should therefore identify the event-order conditions that make the intervention reachable, supportable, or especially consequential, while adding clock or calendar information only where that information performs a genuine analytical or operational role. Relevant predecessor conditions can include institutional readiness, available capacity, accumulated knowledge, affected-subject participation, legal authorization, resource availability, seasonal or ecological conditions, political attention, technological maturity, or the approach of an irreversible transformation.

Definition 11.292 (Intervention timing profile). An *intervention timing profile*

Table 11.16: Temporal architecture of intervention timing and sequencing.

Temporal dimension	Practical object	Characteristic design question	Characteristic concern
Intervention timing	Placement of an intervention event within an ordered practical history	Under which predecessor conditions does the intervention become reachable and consequential?	Clock-time labels can obscure event-order dependence and generative readiness
Possibility windows	Bounded regions of event-order reachability or leverage	Under which temporary relational conditions are actions reachable or especially consequential?	Clock intervals can misrepresent windows generated by event dependencies
Critical junctures	Periods of amplified path formation	When can comparatively small changes alter later institutional or relational trajectories?	Saliency can be mistaken for structural leverage
Generative precedence	Dependency relations among events and capacities	Which event or condition must be generated before another can function as intended?	Calendar order can conceal deeper logical or relational precedence
Operator sequencing	Order-sensitive composition of transformations	Does changing intervention order alter the resulting practical configuration?	Sequence effects can be lost when interventions are treated as additive
Temporal coordination	Alignment across actors, institutions, and timescales	Which activities must occur together, overlap, or remain separated?	Local synchronization can create fragility at another timescale
Delayed effects	Consequences emerging after implementation	Which effects, feedbacks, and burdens appear only after a lag?	Early evaluation can misclassify a trajectory before delayed effects mature
Staged intervention	Bounded sequence of commitments and review gates	Which commitments should be divided into stages with explicit continuation conditions?	Staging can become symbolic if later stages are effectively predetermined
Adaptive sequencing	Revision of order as the field evolves	How should the remaining sequence change after new evidence, events, or capacities emerge?	Undocumented resequencing can become methodological drift

records the contemplated intervention, the relevant temporal horizon, enabling and constraining conditions, urgency, readiness, expected consequences of earlier or later action, reversibility, monitoring capacity, and the conditions under which the timing judgment should be revised.

A useful timing judgment separates at least three temporal questions. *Urgency* concerns how delay changes consequences. *Readiness* concerns whether the practical capacities, authority, knowledge, and safeguards required for action are presently available. *Opportunity* concerns whether the current configuration offers leverage that may later weaken or disappear. These dimensions can diverge. A situation can be urgent while institutional readiness remains weak; a system can be highly ready while the practical benefit of immediate action is small; an opportunity can be unusually favorable even when the underlying problem is not newly urgent.

Timing also changes the meaning of evidence. An observation can be decisive before an irreversible commitment and merely explanatory afterward. A warning signal can have high practical value while options remain open and much lower value

after a cascade has passed a containment point. Section 11.4 therefore matters directly for timing: an epistemic event can modify the field, the action space, or the relative support of later histories. The decision about when to act should consequently include the expected value and performative effects of waiting for additional observation.

A model-specific intervention can be attached to an event e_a whose admissible predecessors are represented by a set $P(e_a)$. One simple event-structure update is given in Equation 11.40.

$$\mathcal{E}' = \mathcal{E} \cup \{e_a\}, \quad \preceq' = \text{tc}(\preceq \cup \{(p, e_a) : p \in P(e_a)\}), \quad (11.40)$$

where tc denotes transitive closure. Equation 11.40 is schematic: it represents intervention timing as insertion or activation within an event-order structure rather than as movement from t to $t + 1$. If a particular model admits an order-compatible scalar clock τ , the intervention event can additionally carry a timestamp $\tau(e_a)$, but that timestamp does not exhaust the temporal relation that gives the intervention its practical meaning. Two interventions with similar clock dates can occupy different positions in the partial order because different epistemic, institutional, or relational predecessors have been generated.

Timing decisions should also preserve the cost of temporal commitment. An intervention that begins now can occupy staff, political attention, infrastructure, legal authority, or financial resources that would otherwise remain available later. Conversely, postponement can preserve flexibility while allowing deterioration or lock-in. A *temporal opportunity-cost record* can therefore document which future capacities or possibilities are consumed, preserved, or generated by acting at the selected time.

11.16.2 Windows of Possibility

A window of possibility is a temporally bounded interval in which a practical action is reachable, legitimate, sufficiently supported, or unusually capable of changing a trajectory. Windows can arise from temporary institutional alignment, resource availability, seasonal conditions, public attention, technological capability, legal authorization, relational trust, or the temporary reversibility of a process. Their methodological importance lies in connecting time to action-space reachability.

Definition 11.293 (Possibility window). A *possibility window* is a bounded region of an event-ordered practical history in which one or more actions possess materially different reachability, expected leverage, legitimacy, reversibility, or implementation conditions than they possess outside that region. Where an order-compatible clock embedding is useful, such a region may also be represented by one or more clock intervals.

A possibility window should be reconstructed through the conditions that open, sustain, and close it. This helps distinguish a genuine temporal opportunity from an arbitrary deadline. A window can open because a coalition forms, a capacity becomes available, a risk becomes visible, or a technical threshold is reached. It can close because attention dissipates, authority changes, a resource is depleted, an institution locks in another trajectory, or an ecological or technical process crosses an irreversible boundary.

Windows can also be generated deliberately. A temporary authorization, pilot in-

frastructure, bridge financing, protected deliberative period, moratorium, reserve capacity, or reversible sandbox can create an interval within which learning and coordinated action become possible. In this sense, timing methodology can itself be generative: praxis can produce the temporal conditions required for a later action rather than merely wait for an exogenous opportunity.

Definition 11.294 (Window-generation intervention). A *window-generation intervention* is an action whose principal temporal function is to create, extend, reopen, or protect an interval in which another practically relevant action becomes reachable, safer, more legitimate, or more revisable.

This concept is useful where immediate substantive intervention remains premature but delay would close the action space. A temporary stabilization measure can preserve a future choice; a short-term legal arrangement can create time for participatory design; reserve capacity can keep rollback possible while evidence accumulates. The resulting intervention should be evaluated partly through the quality of the later action space it preserves or generates.

Possibility windows can differ across subjects. A decision-maker can perceive a wide window because institutional resources allow waiting, while affected subjects experience a narrowing window because harm accumulates daily. Timing analysis should therefore include a *positional window profile* that records whose options expand or contract across the relevant interval. This prevents an institution's capacity to wait from being mistaken for a universally shared temporal condition.

11.16.3 Critical Junctures

A critical juncture is a period in which the practical field exhibits unusually high sensitivity to decisions, events, or institutional commitments relative to surrounding periods. The concept is useful when early changes can redirect later relations, norms, infrastructures, expectations, or action spaces and thereby create persistent path dependence. Within the present framework, a critical juncture is defined through practical sensitivity and path formation rather than through rhetorical importance alone.

Definition 11.295 (Practical critical juncture). A *practical critical juncture* is a temporally localized configuration in which a bounded set of actions or events can materially alter the later generative structure, institutional path, relational organization, or reachable history space of the practical field.

Critical-juncture identification should specify the mechanism of amplified consequence. A new institution may be forming before routines harden. A technical standard may be selected before compatibility networks accumulate. A collective subject may be negotiating internal rules before authority stabilizes. A crisis may temporarily loosen an earlier constraint. These mechanisms differ, and their intervention implications should be modeled separately.

The concept also requires restraint. Visibility, urgency, and political salience can coincide with a critical juncture, yet none of them establishes one by itself. A highly visible event can leave the deeper generative architecture unchanged, while a low-visibility procedural change can strongly shape later possibilities. A *juncture sensitivity profile* should therefore record the target layer, candidate pathways, expected persistence, reversibility, affected positions, and uncertainty concerning the alleged amplification mechanism.

Critical junctures can be epistemically difficult because evidence is often weakest precisely when the field is changing most rapidly. Historical analogies can fail, model parameters can drift, and institutions can improvise. This makes reversibility, staging, plural models, and protected learning especially valuable. It also strengthens the case for preserving the state of knowledge and dissent at the time of commitment so later evaluation does not confuse *ex ante* uncertainty with *ex post* clarity.

A critical juncture can itself be generated by earlier intervention. Capacity building, coalition formation, legal reform, infrastructure creation, or public recognition can accumulate until a previously latent transformation becomes reachable. Timing analysis should therefore consider *juncture preparation*: actions undertaken earlier whose main contribution is to create the relational or institutional conditions under which later structural change can occur.

11.16.4 Event Order and Generative Precedence

Within the present framework, event order is more fundamental than a total calendar sequence. The partial order records which modeled events precede others in the relevant historical, causal, generative, institutional, or procedural sense, while leaving some events incomparable. Calendar order is one optional projection of that richer structure. Generative precedence then identifies a particular class of order relation: an event, capacity, relation, or condition must be established before another event can have its intended practical function. Clock order and generative precedence can coincide, but they need not. An event can have an earlier timestamp yet be generatively irrelevant to a later transformation, while a slowly accumulated capacity can be a necessary predecessor even when no single calendar event marks its completion.

Definition 11.296 (Generative precedence). A practical object x has *generative precedence* over a practical object y within a specified intervention model when the intended generation, activation, legitimacy, reachability, or functioning of y materially depends on the prior establishment or transformation of x .

Generative precedence can involve capability, authority, trust, information, infrastructure, relation, representation, or institutional memory. A monitoring system can require common definitions before data become comparable. Delegated discretion can require competence and accountability pathways before it becomes safely usable. A participatory governance arrangement can require representation and translation capacity before formal participation generates meaningful voice. These examples show why temporal design should reconstruct dependency rather than simply assign dates.

A *precedence graph* can represent such dependencies where a graph is analytically appropriate. Nodes represent intervention-relevant events or conditions, while directed edges encode model-specific precedence relations. In GR, a partial order is not merely a convenient relaxation of a calendar sequence; it is a natural representation of historical time whenever several events can remain unordered or only relational precedence is warranted. Antichains can represent sets of events with no modeled precedence relation among them, while down-sets preserve the event history relevant to a later transformation. A labeled 2-complex can enrich this representation when higher-order relational composition matters. This connects timing methodology directly to the partial-order and 2-complex models developed in Section 11.12.

Generative precedence is especially important for historical-relational subjects.

An intervention can seek to transform a present capacity whose existence depends on earlier relations, institutions, or recognitional events. Direct intervention at the present manifestation may be fragile if the antecedent conditions that regenerate the capacity remain unchanged. Conversely, recreating an earlier condition can be inappropriate if the subject's historical trajectory has transformed the meaning of that condition. Precedence analysis therefore reconstructs dependency without assuming historical reversibility.

Definition 11.297 (Precedence remainder). A *precedence remainder* records unresolved, disputed, or weakly observed dependencies that may affect the proposed intervention sequence but cannot yet be assigned a stable precedence relation.

Preserving this remainder matters because a falsely precise sequence can be more dangerous than an explicitly incomplete one. Where precedence remains uncertain, staged intervention and monitoring can be designed to test or revise the dependency structure as praxis proceeds.

11.16.5 Order-Sensitive Operator Sequencing

Order-sensitive operator sequencing formalizes cases in which intervention composition is noncommutative. The practical configuration produced by applying transformation a and then transformation b can differ from the configuration produced by reversing their order. Section 11.12 introduced operator algebra as one possible representation of such order dependence. Timing methodology now uses that representation to design intervention sequences.

Equation 11.41 states the basic noncommutative case.

$$\Phi_b \circ \Phi_a \neq \Phi_a \circ \Phi_b. \quad (11.41)$$

Equation 11.41 compares two alternative admissible event orders rather than two points on a presumed universal clock. It has substantive meaning only when the operators and their domains are specified. The inequality can arise because the first transformation changes the domain, parameters, institutional authority, subject configuration, or action space on which the second transformation operates. The formal expression should therefore be accompanied by a practical account of the mechanism generating the order effect.

One common form involves epistemic events. Observation followed by institutional recognition can differ from recognition followed by observation because recognition can alter reporting behavior, access, categories, or incentives before the observation occurs. Participation before design can generate options that would not exist if design were completed first. Pilot deployment before full authorization can produce evidence that changes later institutional criteria, while full authorization before a pilot can make subsequent evaluation politically or institutionally difficult to interpret.

Definition 11.298 (Sequence-effect profile). A *sequence-effect profile* records the compared intervention orders, the model or interpretation supporting order sensitivity, the practical mechanisms through which earlier events alter later transformations, affected positions, expected history-space effects, and uncertainty concerning the comparison.

Operator sequencing can also contain partial reversibility. If Φ_a changes a field in a way that enables Φ_b , reversing Φ_a after Φ_b may fail to restore the earlier configuration

because Φ_b has already generated new relations or dependencies. Sequence design should therefore distinguish algebraic inverse notation from practical rollback. A formal inverse can be unavailable, approximate, or practically meaningless even when a technical reversal procedure exists.

Noncommutative sequencing does not imply that operator algebra is required for every intervention. Narrative, process-tracing, workflow, partial-order, simulation, or institutional models can represent the same substantive order dependence where they better fit the practical object. The formalism earns its place when composition rules clarify sequence effects that ordinary calendar description would obscure.

11.16.6 Temporal Coordination

Temporal coordination concerns alignment among interdependent actions occurring across actors, institutions, infrastructures, or timescales. Within an event-order representation, coordination can concern precedence, permitted concurrency, synchronization under an auxiliary clock, overlap, or deliberate separation. Events that are incomparable in the partial order are not thereby asserted to be simultaneous; they are simply left without a modeled precedence relation. Coordination methodology specifies these relations rather than assuming that every component can be independently scheduled on one common timeline.

Definition 11.299 (Temporal coordination profile). A *temporal coordination profile* records interdependent activities, responsible positions, required ordering or overlap, synchronization tolerances, communication interfaces, buffer capacity, fallback arrangements, and consequences of early, late, or missing coordination.

Coordination can be tight or loose. Tight synchronization can be necessary when a protective service, technical transition, legal authorization, and communication system must activate together. Loose coordination can be more robust when actors need autonomy to adapt locally or when synchronization failure would create a common-mode risk. Temporal design should therefore evaluate the consequences of coordination intensity rather than treating synchronization as inherently desirable.

Different timescales create additional problems. A fast operational process can depend on slow maintenance, training, institutional trust, ecological regeneration, or legal review. Optimizing the fast process can consume the slow capacity that sustains it. Conversely, slow institutional reform can fail to protect actors facing immediate harm. A *timescale coordination map* should therefore connect rapid interventions to the slower processes that enable, constrain, or absorb them.

Temporal coordination also has a power dimension. Actors with greater resources can often absorb delay, accelerate procedures, or synchronize around their own schedules. Others bear waiting costs, missed access, or participation burdens. A coordination plan should therefore record how timing burdens and flexibility are distributed. This is especially important when the institution organizing the process experiences delay as administratively convenient while affected subjects experience it as cumulative harm.

Coordination interfaces should include communication and state handoff. If one stage finishes but the next stage receives only a result rather than the assumptions, uncertainty, unresolved dissent, or maintenance requirements attached to that result, temporal continuity can conceal epistemic discontinuity. The practical handoff should therefore transmit both the intervention state and the provenance needed to

interpret it.

11.16.7 Delayed Effects

Delayed effects arise when consequential events occur downstream of an intervention event through a nontrivial chain of ordered transformations, or when their clock-time manifestation is separated from the intervention by a substantial lag. Delay can result from accumulation, institutional learning, ecological processes, infrastructure depreciation, trust formation, network propagation, demographic turnover, legal implementation, or slow transformation of norms and expectations. Timing methodology should therefore distinguish event-order distance and dependency from clock-time duration.

Definition 11.300 (Delayed-effect profile). A *delayed-effect profile* records anticipated consequence types, expected latency, affected positions, propagation pathways, observability conditions, competing explanations, relevant timescales, and the review horizon required before a practical judgment should be treated as sufficiently mature.

Delayed effects can produce systematic evaluation errors. An intervention can appear successful because immediate indicators improve while maintenance capacity is being depleted. It can appear unsuccessful because beneficial institutional learning has not yet matured. It can distribute early benefits to one group and delayed burdens to another. Evaluation schedules should therefore be connected to the generative mechanism rather than selected solely for administrative convenience.

Where an order-compatible continuous-time embedding is substantively useful, a present observable can depend on earlier interventions through a model-specific response kernel. Equation 11.42 gives one such specialization.

$$Y_t^{(m)} = \int_0^\infty D^{(m)}(\tau) G^{(m)}(\omega_{t-\tau}, a_{t-\tau}, e_{t-\tau}) d\tau. \quad (11.42)$$

Equation 11.42 is a continuous-time specialization rather than the GR definition of temporal structure. The delay kernel $D^{(m)}$ requires locally justified semantics and estimation where quantitative use is intended. In event-ordered models, delayed consequence can instead be represented through chains, path lengths, precedence depth, or other relations on the partially ordered history. Many practical settings are better served by qualitative lag categories, historical reconstruction, event studies, or simulations.

Delayed effects also interact with reversibility. A process can remain easy to stop while its consequences continue propagating because earlier commitments created durable dependencies. Conversely, an action can be difficult to reverse while some of its measurable consequences remain delayed. A timing record should therefore distinguish *commitment latency*, *effect latency*, and *recovery latency*. These different temporal structures can imply different monitoring and rollback designs.

The possibility of delayed harm creates a responsibility horizon extending beyond immediate implementation. An institution that closes a project when the implementation period ends can leave later actors without records, monitoring capacity, or authority to respond. Delayed-effect analysis should therefore connect directly to the long-horizon responsibility and practical-closure architectures developed in Chapter

10.

11.16.8 Staged Intervention

Staged intervention divides a practical commitment into temporally ordered components whose continuation, modification, escalation, or termination depends on conditions observed during implementation. Staging can reduce exposure, preserve options, generate evidence, build capacity, and reveal sequence effects before deeper commitments are made. It is particularly useful where uncertainty is substantial and reversibility declines with commitment depth.

Definition 11.301 (Staged intervention architecture). A *staged intervention architecture* specifies a sequence of bounded commitments together with stage objectives, entry conditions, monitoring objects, review gates, continuation criteria, escalation and de-escalation pathways, rollback provisions, and the information that must be transferred between stages.

A stage should have genuine practical significance. Administrative phases that pre-authorize the full trajectory may preserve little learning or reversibility. A meaningful review gate retains authority and practical capacity to alter the subsequent path. Diagnostic, capability, pilot, protective, and coordination stages can therefore serve different functions and should carry correspondingly different evidence and continuation criteria. This connects staging to the reversible-commitment and escalation architectures developed in Section 11.10.

Staging also changes the field. Learning, investment, expectations, infrastructure, and reputational commitments can make a nominally reversible pilot difficult to withdraw. A *stage lock-in profile* should therefore record dependencies, sunk investments, contractual commitments, and legitimacy claims that can transform a bounded stage into durable commitment.

Definition 11.302 (Stage lock-in profile). A *stage lock-in profile* records the practical mechanisms through which a bounded intervention stage can increase the cost, difficulty, or legitimacy burden of later revision, rollback, or exit.

Staging should also avoid transferring uncertainty burdens disproportionately. A pilot can protect the institution from large-scale commitment while concentrating experimentation risk on a small affected population. The stage architecture should therefore document who bears learning costs, who receives benefits, who can contest continuation, and how harms discovered during the stage will be repaired.

11.16.9 Adaptive Sequencing

Adaptive sequencing governs revision of the remaining intervention order as the practical field evolves. It extends staged intervention by allowing not only continuation or termination, but also reordering, insertion, removal, branching, or regeneration of later steps after new epistemic events, capacities, institutions, or consequences emerge. The sequence therefore becomes a revisable practical object rather than a fixed implementation schedule.

Definition 11.303 (Adaptive sequencing rule). An *adaptive sequencing rule* specifies the observations, epistemic events, capacity changes, consequence patterns, institutional conditions, or action-space transformations that can trigger revision of the

remaining intervention order, together with the authority and provenance requirements governing that revision.

A model-specific sequence state can be represented by a planned partial order σ together with the currently realized event history $\mathcal{H}_{\text{real}}$, the practical configuration, and the epistemic state. Equation 11.43 gives a schematic update.

$$\sigma' = \mathcal{S}(\sigma, \mathcal{H}_{\text{real}}, \omega, e, \mathcal{A}, \mathcal{I}). \quad (11.43)$$

Equation 11.43 indicates that sequence revision can depend on the realized event structure, the transformed field, epistemic events, the updated action space, and institutional conditions. The revised σ' can change precedence relations, add branches, leave additional events unordered, or introduce clock-time constraints where operational synchronization requires them. Revision can be qualitative, participatory, computational, or hybrid according to the intervention.

Adaptive sequencing requires provenance. If a sequence $a \rightarrow b \rightarrow c$ changes to $a \rightarrow d \rightarrow b$, the record should preserve the trigger, justification for d , any changed meaning of b , and consequences for responsibility and evaluation. This prevents later reconstruction from treating adaptation as though it had been the original plan.

Definition 11.304 (Sequence revision record). A *sequence revision record* preserves the prior intervention order, triggering events or observations, revised precedence relations, inserted or removed stages, changes in expected consequences, responsible authority, remaining uncertainty, and implications for evaluation, rollback, and later learning.

Adaptive sequencing can also generate or foreclose actions. A stage that creates trust, knowledge, institutional memory, or technical capability can make a previously absent intervention reachable, while an adverse event can close a planned branch. The temporal architecture should therefore remain coupled to the action-space regeneration framework of Sections 11.7 and 11.10.

Proposition 11.305 (Temporal-generative intervention design). *Within the present framework, intervention timing is methodologically adequate when the practical design represents the event-order relations through which actions become reachable and consequential, and, where useful, their clock-time labels; it should also represent how precedence, concurrency, order-sensitive composition, and delay alter subject and institutional configuration, reversibility, learning, and the later intervention structure itself.*

The proposition completes the temporal layer of intervention design. Target selection identifies the practical objects to be changed; timing and sequencing identify the temporal relations through which change is attempted. Section 299 next develops scale selection, historical-relational resolution, coarse-graining, and scale translation before intervention depth is specified.

11.17 Scale Selection

Section 11.15 distinguished layers at which intervention can be targeted, while Section 11.16 developed the event-ordered temporal architecture within which interventions are sequenced. The present section addresses a different design problem: the scale and resolution at which a practical configuration should be represented, governed, and transformed. Its role within Chapter 11 is to prevent intervention design

from silently assuming that the scale at which a problem becomes visible is also the scale at which it is generated, governed, or repairable. Its objective is to develop a multiscale methodology spanning individual, interpersonal, organizational, community, institutional, and field-level praxis while also distinguishing practical scale from historical and relational resolution. The discussion proceeds through scale-specific analysis, multiscale coupling, coarse-graining, scale translation, and the diagnosis of scale mismatch.

Definition 11.306 (Practical scale). A *practical scale* is a model-relative level of organization, interaction, authority, or consequence at which actors, relations, events, capacities, institutions, or fields are represented for diagnosis, decision, intervention, monitoring, or evaluation.

Definition 11.307 (Representational resolution). *Representational resolution* is the granularity with which a practical model distinguishes events, relations, subjects, histories, spatial or institutional positions, and transformation pathways within a selected scale.

Scale and resolution should remain distinct. An organizational-scale analysis can be coarse, representing only formal departments and aggregate flows, or fine, representing particular roles, event sequences, interfaces, and historical dependencies. Conversely, a fine-grained event history can span several organizational or institutional scales. The distinction is especially important under the event-ordered temporal architecture developed in Section 11.16: increasing temporal resolution need not mean subdividing a scalar clock interval; it can mean distinguishing additional events, precedence relations, branches, and relational dependencies within a partial order.

Scale selection also need not imply a single nested hierarchy. Individuals participate in several organizations, communities can cross institutional jurisdictions, fields can connect actors located in different organizations and territories, and one historical-relational subject can itself contain internally differentiated scales. Practical scales can therefore overlap, intersect, and partially embed one another. The methodological task is to specify which scale relations are being represented rather than to presume a universal micro–macro ladder.

Table 11.17 summarizes the section’s scale architecture. The table is not a hierarchy of increasing importance. Each scale can become analytically primary depending on the problem, and practical adequacy often depends on preserving interfaces among several scales.

11.17.1 Individual Scale

Individual-scale intervention concerns the practical configuration of a person or another analytically individuated subject. Within GR, however, the individual should not be presumed to be an isolated point bearing fixed preferences or capacities. Sections 11.7 and 11.12 treated subjects as potentially historical-relational objects whose present configuration can contain internal organization, accumulated events, institutional positions, classifications, capacities, commitments, and relations to other subjects. Scale selection therefore asks what can responsibly be represented at the individual scale while preserving the relations through which the individual has been constituted.

Definition 11.308 (Individual-scale practical profile). An *individual-scale practical*

Table 11.17: Scale-selection dimensions in applied praxis.

Scale or resolution	Primary analytical object	Characteristic design question
Individual	Historical-relational subject, capability, standing, internal organization	Which subject-level capacities or conditions are practically transformable?
Interpersonal	Dyads and small relational configurations	Which relations of dependence, trust, care, authority, or exchange mediate the problem?
Organizational	Roles, routines, workflows, interfaces, collective capacity	Which organizational processes reproduce or can transform the practical condition?
Community	Shared practices, membership, local infrastructures, collective memory	Which locally constituted relations and capacities support or constrain collective praxis?
Institutional	Rules, mandates, authority, durable classifications, accountability	Which durable arrangements govern admissible action and responsibility?
Field	Distributed relations across organizations, institutions, and positions	Which wider topology, incentives, dependencies, or distributed conditions shape local trajectories?
Historical / relational resolution	Events, precedence, relations, branches, internal structure	Which distinctions must remain visible for the relevant generative mechanism to be represented?
Multiscale	Coupled transformations across several scales	Which scale interactions must be coordinated rather than treated independently?
Coarse-graining / translation	Maps between finer and coarser representations	Which information and generative structure survive translation across resolutions?
Scale fit	Alignment among target, mechanism, authority, observation, consequence, and repair	Where does a mismatch among practical scales distort intervention design?

profile records the subject-level capacities, constraints, internal organization, historical events, institutional positions, relations, available actions, and relevant uncertainty that materially shape the practical problem at the selected level of individuation.

Individual-scale methods can be appropriate when intervention targets a subject's capability, knowledge, health, skill, practical autonomy, recognized standing, internal coordination, or another subject-level condition. They are also useful when actors occupying similar structural positions nevertheless follow different trajectories because their histories, internal resources, or relational configurations differ. The scale becomes analytically weak when it absorbs into the individual mechanisms that operate primarily through institutions, fields, infrastructures, or relations among subjects.

An individual-scale representation should therefore include an *external-relational boundary*. The boundary records which relations and institutional conditions remain

outside the subject model but materially affect the subject's options or consequences. This makes visible the degree to which an apparently individual target depends on a wider practical architecture. For example, capability formation can be modeled at the subject scale while the opportunity to exercise that capability depends on organizational authorization or field-level access.

Individual scale also raises a resolution question. A subject can be represented coarsely through a few state variables, or more richly through an event-ordered historical structure. Where a subject's continuity and capacity depend on a sequence of formative events, a partial-order or labeled 2-complex representation may preserve distinctions that a point-state representation removes. The model should become more detailed only where the additional resolution changes diagnosis, intervention design, or responsibility.

11.17.2 Interpersonal Scale

Interpersonal-scale analysis takes relations among a small number of subjects as the primary practical object. The relevant relation can concern trust, care, communication, authority, dependency, recognition, exchange, conflict, learning, or another interaction whose properties are not reducible to the separate attributes of the participating subjects. This scale is especially important where the mechanism of change lies in the relation itself.

Definition 11.309 (Interpersonal intervention scale). An *interpersonal intervention scale* represents a bounded configuration of relations among subjects as the primary locus of practical diagnosis or transformation while retaining the subject histories and wider institutional conditions needed to interpret those relations.

Interpersonal relations can be asymmetric. A relation of dependence can give one subject greater capacity to delay, exit, define the problem, or impose uncertainty on another. A trust relation can permit coordination while simultaneously concentrating vulnerability. An intervention that changes one subject's behavior without changing the relation can therefore leave the generative mechanism intact. Conversely, relational redesign can alter both subjects even where neither is directly targeted as an isolated entity.

This scale also allows practical analysis of reciprocal and circular effects. Recognition by one subject can alter another subject's self-understanding, which can alter subsequent interaction. Communication can generate new shared categories that change later observations. These are naturally represented as event-ordered relational processes rather than as independent updates to fixed individual states.

Interpersonal analysis should nevertheless avoid assuming that all relational problems can be solved at the dyadic scale. A relation can be generated or stabilized by organizational roles, legal classifications, economic dependence, or field-level norms. The method should therefore record which interpersonal properties are locally transformable and which are inherited from wider scales.

11.17.3 Organizational Scale

Organizational-scale intervention concerns coordinated systems of roles, routines, workflows, authority, information, resources, and internal interfaces. Organizations

can generate collective capacities that no single member possesses, while also producing bottlenecks, memory loss, coordination failure, or concentrated authority. The organizational scale is therefore more than an aggregation of individuals.

Definition 11.310 (Organizational-scale configuration). An *organizational-scale configuration* is a practical representation of roles, authority, routines, interfaces, resources, information flows, memory structures, and collective capacities through which an organization produces and revises action.

Scale selection at this level asks whether the practical mechanism is reproduced through organizational arrangement. A recurring failure can arise because information does not cross departmental boundaries, because responsibility is fragmented across interfaces, because formal authority is disconnected from implementation capacity, or because institutional memory is lost during personnel turnover. These mechanisms cannot be reconstructed adequately by summing individual traits.

Organizational intervention can target internal topology. It can alter role distribution, decision rights, escalation pathways, information interfaces, maintenance routines, or memory handoffs. It can also generate new collective capabilities through coordination and trust. Such changes often have event-order effects: training before delegation can produce a different organizational history from delegation before training; protected reporting before evaluation can generate different evidence from evaluation before reporting protections exist.

The organizational scale can conceal internal heterogeneity if used too coarsely. A single organizational node in a field-level network can contain multiple positions with conflicting interests, unequal exposure, and distinct knowledge. When these differences materially affect intervention, the representation should reopen the organization and increase resolution rather than treating it as an indivisible actor.

11.17.4 Community Scale

Community-scale analysis concerns practical configurations organized through shared locality, practice, identity, infrastructure, history, association, or other forms of collective relation that do not necessarily coincide with formal organizational boundaries. The term *community* should therefore identify a model-specific relational configuration rather than presume homogeneity, consensus, or fixed membership.

Definition 11.311 (Community-scale practical configuration). A *community-scale practical configuration* is a bounded and revisable representation of shared practices, relations, infrastructures, collective memory, local knowledge, membership conditions, internal differences, and external interfaces that materially shape collective praxis.

Community scale can be important when local knowledge, informal support, shared infrastructure, repeated interaction, or collective memory generates practical capacity unavailable through formal institutions alone. It can also reveal burdens that disappear in administrative aggregates. Participatory mapping and local-knowledge methods developed in Sections 11.13 and 11.14 can therefore be especially useful at this scale.

Community boundaries can themselves be contested or generated through intervention. Recognition, funding, legal designation, infrastructure, or participatory pro-

cedures can stabilize one membership boundary and weaken another. A community intervention can therefore change the practical object it claims merely to support. A *community-boundary record* should preserve the criteria, contributors, exclusions, overlaps, and revision conditions through which the represented community was defined.

Internal heterogeneity remains central. A community can contain unequal authority, unequal ability to participate, divergent histories, and competing interpretations. Community-scale analysis should therefore preserve intra-community relations where they are materially relevant rather than treating a collective label as evidence of shared interest.

11.17.5 Institutional Scale

Institutional-scale intervention concerns durable rules, classifications, mandates, authority structures, procedures, expectations, and accountability arrangements that organize practical possibility across repeated cases and actors. Institutions can span several organizations and persist through turnover in individual participants. Their effects are therefore often temporally and organizationally distributed.

Definition 11.312 (Institutional-scale intervention). An *institutional-scale intervention* targets the durable rules, mandates, classifications, procedures, authority relations, accountability pathways, or memory structures through which repeated practical situations are organized.

This scale is appropriate when local variation is generated by a common institutional architecture. Repeated burdens can arise from one classification rule, authorization procedure, reporting standard, or allocation logic even when implementation occurs through many organizations. Institutional intervention can therefore transform the conditions under which local actors act rather than instructing each actor separately.

Institutional scale also requires attention to enactment. Formal rules can differ from operational practice, and informal adaptations can become the effective institution. Section 11.2 distinguished formal design from enacted institutional configuration. Scale selection should carry that distinction forward: a formal institutional target can be too coarse if the practical mechanism lies in local interpretation, implementation routines, or interface practices.

Institutional change can have long event-order consequences. A classification introduced at one historical moment can shape later data, recognition, resource access, and organizational routines. The intervention therefore affects not only present rules but also the future epistemic events through which the field becomes represented. Institutional-scale evaluation should retain this historical propagation rather than treating reform as a single-date rule change.

11.17.6 Field Scale

Field-scale analysis represents distributed relations extending across multiple organizations, institutions, communities, infrastructures, or positions. The relevant practical object can include flows of authority, knowledge, resources, legitimacy, risk, dependency, standards, or opportunity that cannot be localized to one institutional unit.

A field is therefore defined by the relational structure represented, not simply by territorial size.

Definition 11.313 (Field-scale practical representation). A *field-scale practical representation* models distributed relations, positions, flows, constraints, opportunities, and transformation conditions across multiple organizational or institutional loci whose interaction materially shapes the practical trajectory.

Field-scale methods are useful when local interventions repeatedly encounter the same wider incentives or dependencies. An organization can change its internal procedure yet remain constrained by external standards, resource flows, professional norms, infrastructure, or concentrated gatekeeping. Conversely, a field-level reform can fail if it assumes organizations possess local capacities they do not have.

Fields can be represented through networks, higher-order structures, distributed fields, institutional maps, historical narratives, or mixed models. The representation should preserve the mechanism relevant to intervention. A network can show topology while concealing meaning; a field representation can show distributed intensity while concealing organizational authority; an institutional narrative can preserve meaning while offering limited quantitative resolution. Method plurality therefore remains necessary at this scale.

Field-scale intervention also raises distributional questions. A change that improves aggregate coordination can concentrate vulnerability in one position or transfer maintenance burdens across organizations. Field-scale robustness should therefore be assessed together with the cross-scale and justice architectures developed earlier in the chapter and in Chapter 10.

11.17.7 Historical and Relational Resolution

Historical and relational resolution concerns how finely a representation distinguishes the events and relations through which a practical configuration has been formed. This dimension should remain separate from organizational or institutional scale. A field-level model can use fine event resolution, while an individual-scale model can remain coarse. The appropriate resolution depends on which distinctions materially affect the generative mechanism, decision, or evaluation.

Definition 11.314 (Event-relational resolution). *Event-relational resolution* is the granularity with which a model distinguishes events, precedence relations, relational types, subject boundaries, branches, and higher-order compositions within a represented practical history.

Under the temporal architecture of Section 11.16, increasing historical resolution does not require subdividing a universal scalar timeline. It can instead mean distinguishing previously aggregated events in the partial order, identifying a new precedence relation, separating one relation into several typed relations, or resolving a coarse subject into an internally structured historical-relational object. The refinement is warranted when these distinctions change inference or intervention design.

Resolution also affects causal and normative attribution. A coarse representation can make one institutional decision appear to produce a later consequence directly, while a finer event structure reveals intervening adaptation, translation, resistance, or additional decisions. Conversely, excessive resolution can make a stable higher-order pattern difficult to see. The objective is therefore neither maximal detail nor

maximal aggregation, but preservation of the distinctions needed for the practical question.

Definition 11.315 (Resolution adequacy profile). A *resolution adequacy profile* records which events, relations, subject boundaries, historical dependencies, and higher-order structures are distinguished at the current resolution, which are aggregated, and what practical claims depend on those choices.

Resolution can itself change during praxis. A new epistemic event can reveal that a formerly adequate aggregate category contains materially different substructures. Monitoring can discover that one “implementation stage” actually contains several order-sensitive events. Conversely, repeated evidence can justify aggregation where finer distinctions no longer alter the practical judgment. Resolution should therefore remain versioned and revisable.

11.17.8 Multiscale Intervention

Multiscale intervention coordinates transformations at more than one practical scale when the generative mechanism crosses scale boundaries. Such intervention is not equivalent to applying several independent interventions simultaneously. The relevant issue is how transformations at different scales enable, constrain, amplify, absorb, or counteract one another.

Definition 11.316 (Multiscale intervention architecture). A *multiscale intervention architecture* specifies the practical scales involved, the intervention object at each scale, cross-scale dependencies, direction of influence, temporal ordering, authority, information interfaces, expected feedback, and conditions for coordinated revision.

A subject-level capability programme can fail when organizational roles leave no opportunity to exercise the capability. An institutional reform can fail when organizations lack implementation capacity. A field-level standard can create local compliance without changing the interpersonal relation that generates harm. These cases show why cross-scale coupling should be represented before intervention depth or mechanism is fixed.

Cross-scale influence can move in several directions. Higher-scale arrangements can condition local possibilities through rules, resources, infrastructure, or categories. Local innovation can propagate upward through learning, coalition formation, replication, or institutional revision. Repeated interpersonal interaction can generate community norms, while field-level narratives can alter interpersonal expectations. Multiscale methodology should therefore avoid a one-directional micro-to-macro or macro-to-micro assumption.

The event-ordered temporal architecture is useful here because scale interactions can have precedence without sharing one common clock. Organizational readiness can be a predecessor of institutional delegation; local evidence can precede field-level standard revision; a field-level recognition event can precede organization-level implementation. A multiscale history can therefore be represented through partially ordered events carrying scale labels rather than through one sequence of synchronized aggregate states.

Definition 11.317 (Cross-scale coupling record). A *cross-scale coupling record* documents a represented dependency or feedback between practical scales, including the events or relations that mediate the coupling, its direction, uncertainty, temporal

structure, affected positions, and implications for intervention coordination.

Multiscale intervention also requires division of responsibility. The actor capable of changing a local relation may lack authority over the institutional rule generating it. The institution capable of changing the rule may lack local knowledge required for implementation. Effective architecture therefore aligns scale-specific authority and capacity while retaining interfaces for learning and contestability.

11.17.9 Coarse-Graining and Scale Translation

Coarse-graining constructs a lower-resolution representation from a more differentiated practical configuration. Scale translation connects objects or claims across representations that differ in scale or resolution. Both operations can be useful, but neither is epistemically neutral. Aggregation can preserve some structures while erasing others, and translation can preserve practical correspondence without establishing identity between the represented objects.

Definition 11.318 (Practical coarse-graining). A *practical coarse-graining* is a documented transformation from a finer practical representation to a coarser representation that specifies which events, relations, subject distinctions, histories, or local variations are merged, summarized, or omitted and which practical properties are intended to remain interpretable after the transformation.

For event-ordered histories, a coarse-graining can be represented by an order-preserving map between partially ordered event sets. Equation 11.44 gives one model-specific form.

$$q : (\mathcal{E}, \preceq) \longrightarrow (\bar{\mathcal{E}}, \bar{\preceq}), \quad e_1 \preceq e_2 \implies q(e_1) \bar{\preceq} q(e_2). \quad (11.44)$$

Equation 11.44 requires order preservation for precedence relations that the coarse representation claims to retain. The map can merge several fine events into one coarse event or omit distinctions irrelevant to the current task. Other coarse-graining schemes can be appropriate where the represented object is a network, field, organization, probability model, or narrative history.

Coarse-graining becomes especially informative when combined with transformation. If a fine-scale intervention operator is Φ and the corresponding coarse representation uses $\bar{\Phi}$, the relation in Equation 11.45 provides one test of scale consistency.

$$q(\Phi(\omega)) \stackrel{?}{=} \bar{\Phi}(q(\omega)). \quad (11.45)$$

Equation 11.45 is not expected to hold universally. Approximate agreement can indicate that the coarse model preserves the intervention-relevant transformation over the stated domain. Systematic nonagreement can reveal that aggregation removes interaction, threshold, history, or heterogeneity effects necessary for the practical claim. The failure to commute can therefore be diagnostically valuable rather than merely a technical defect.

Definition 11.319 (Scale-translation remainder). A *scale-translation remainder* records events, relations, meanings, heterogeneity, path dependence, uncertainty, or normative differences that materially affect practical interpretation but are not preserved by the selected coarse-graining or cross-scale translation.

Scale translation should preserve provenance. A field-level indicator derived from

organization-level records should retain enough information to reconstruct how local categories were aggregated. A community narrative translated into an institutional classification should record what meanings were compressed or transformed. A subject-level effect inferred from aggregate data should identify the assumptions required for that movement across scale. This prevents practical conclusions from acquiring false universality merely because the path of translation has been forgotten.

11.17.10 Scale Mismatch

Scale mismatch arises when the scale at which a problem is represented, governed, observed, acted upon, or evaluated does not align sufficiently with the scale at which the relevant generative mechanism or consequence operates. Mismatch is therefore relational: there is no universally correct scale independent of the practical task.

Definition 11.320 (Scale-mismatch profile). A *scale-mismatch profile* compares the scales of problem representation, target, generative mechanism, authority, capability, observation, consequence, evaluation, and repair, and records where their misalignment materially distorts reachability, attribution, implementation, burden distribution, or revision.

Several recurrent forms can be distinguished. A *target-mechanism mismatch* occurs when intervention is directed at one scale while the mechanism generating the condition lies mainly at another. An *authority-problem mismatch* occurs when the responsible actor lacks jurisdiction over the relevant scale. An *observation-consequence mismatch* occurs when monitoring captures local short-run effects while consequences propagate across wider or slower structures. A *repair mismatch* occurs when harm is generated systemically but remedy is assigned to individual actors. A *resolution mismatch* occurs when the representation is too coarse or too fine to preserve the structure needed for practical inference.

Scale mismatch can also be generated by intervention. A local pilot can create a field-level standard. A field-level classification can individualize responsibility for a structural condition. An institutional reform can push unresolved burden into community or interpersonal relations. Evaluation should therefore ask how intervention redistributes practical problems across scales rather than assuming that successful change at the focal scale resolves the wider trajectory.

Mismatch does not automatically imply that the intervention should be moved to the largest scale available. Wider intervention can weaken local adaptation, exceed legitimate authority, obscure heterogeneity, or create coordination burdens. A practical response can instead involve multiscale coordination, changed representation, delegation, interface design, capability formation, or altered sequencing. The appropriate correction depends on the specific relation among scales.

Proposition 11.321 (Scale-selection adequacy). *Scale selection is practically adequate to the extent that the chosen representation preserves the actors, relations, events, historical dependencies, authorities, consequences, and cross-scale couplings needed for the intervention claim, while its coarse-graining and translation choices remain explicit, revisable, and proportionate to the decision task.*

Proposition 11.321 connects scale selection to the larger methodological architecture of this chapter. Scale should be selected with the target, history, model, timing, authority, uncertainty, and evaluation object in view. The resulting scale architecture

can remain plural: different components of one intervention may require different scales and resolutions, provided the interfaces among them are represented and governed.

Scale selection still does not determine how deeply intervention should transform the selected object. A change at institutional scale can be shallow, modifying one parameter or procedure, or deep, altering the generative rule by which later institutional states are produced. The next section therefore turns from the location and resolution of intervention to *intervention depth*.

11.18 Intervention Depth

Sections 11.15–11.17 specified the target, temporal architecture, and scale of intervention. The present section addresses a different design dimension: how far intervention should reach into the generative organization of the practical configuration. Its role within Chapter 11 is to distinguish interventions that stabilize manifestations or current states from interventions that transform relations, historical-relational subjects, structures, constraints, capacities, institutions, observation regimes, or the rules by which later histories are generated. Its objective is to make intervention depth explicit enough that practical ambition, epistemic burden, legitimacy, reversibility, and possible generative consequence can be evaluated together. The discussion proceeds from surface and state intervention through progressively more generative layers, while treating depth as multidimensional and model-relative rather than as a universal ladder of increasing desirability.

Definition 11.322 (Intervention depth). *Intervention depth* is the extent to which an intervention is intended to modify the represented conditions, relations, subject configurations, structures, capacities, institutions, observation regimes, or generative rules through which later practical states and histories are produced.

Definition 11.322 concerns the represented generative architecture rather than physical penetration, organizational size, budget, or political visibility. An intervention can be large in scale yet shallow in depth if it repeatedly changes current outputs while leaving the generative structure largely intact. A small intervention can be deep if it changes a classification, permission rule, relation, or institutional interface that reorganizes many later possibilities. Depth is therefore indexed to the model and the practical mechanism under consideration.

Intervention depth should also remain distinct from intervention target. The same target can be addressed at different depths. An institution can be targeted by changing one administrative output, one current state, a recurring relation among roles, its internal capacity, its mandate, or the rule by which later decisions are generated. Conversely, one intervention can couple several depths simultaneously. The methodological task is to identify which layers are intentionally transformed, which are expected to change only as consequences, and which should remain protected from unnecessary intervention.

Definition 11.323 (Intervention-depth profile). An *intervention-depth profile* records the represented layers intentionally transformed by an intervention, the layers expected to change indirectly, the generative mechanism connecting them, the expected persistence and reversibility of those changes, the affected positions, the epistemic and institutional requirements for acting at that depth, and the conditions for revi-

Table 11.18: Intervention-depth layers in applied praxis.

Depth layer	Primary transformation object	Characteristic methodological concern
Surface	Manifested condition, interface, or immediate exposure	Stabilization, protection, relief, and preservation of later options
State	Current configuration within a relatively stable generative rule	Persistence, recurrence, and dependence on unchanged dynamics
Relational	Relations among subjects, positions, or components	Reciprocity, asymmetry, dependency, trust, authority, and spillovers
Historical-relational subject	Subject configuration, standing, capability, internal organization, or event history	Agency, consent, continuity, path dependence, and subject transformation
Structural	Recurrent topology or organization of relations and positions	Reproduction mechanisms, cross-scale effects, and structural persistence
Constraint	Conditions limiting or shaping reachable actions and histories	Protective versus restrictive functions and constraint substitution
Capacity	Ability to sense, decide, coordinate, act, maintain, repair, or revise	Activation pathways, sustainability, distribution, and capability decay
Institutional	Mandates, roles, routines, accountability, memory, and durable coordination	Legitimacy, implementation, institutional transition, and handoff
Observation and representation	Categories, indicators, measurement, visibility, and interpretive regimes	Performative epistemic effects, classification power, and representation error
Rule	Transformation, update, permission, or composition rules	Wide downstream consequence, path dependence, and governance of rule revision
Depth risk	Cross-layer consequence generated by deep intervention	Irreversibility, model error, legitimacy, capture, option loss, and repair capacity

sion or withdrawal.

Table 11.18 summarizes the section’s depth architecture. The rows should not be read as a universal sequence through which every intervention must proceed. They identify analytically different transformation objects. A practical design can combine several rows, and an intervention can become deeper through one dimension while remaining shallow through another. The relevant question is whether the selected depth fits the represented generative mechanism and the practical conditions for responsible action.

11.18.1 Surface Intervention

Surface intervention acts principally on a manifested condition, interface, exposure, or immediate practical consequence while leaving the deeper represented generative architecture largely unchanged. The term *surface* is descriptive rather than dismiss-

sive. Immediate stabilization, protection, relief, access provision, containment, or temporary substitution can be practically decisive even when the conditions generating the problem remain in place.

Definition 11.324 (Surface intervention). A *surface intervention* is an intervention whose primary intended effect is to alter a manifested condition, immediate exposure, practical interface, or short-horizon consequence without requiring substantial transformation of the represented relations, structures, institutions, or generative rules producing that condition.

Surface intervention is often appropriate where harm must be reduced before a deeper diagnosis is complete. It can preserve life, safety, continuity, access, or organizational function while research and deliberation continue. It can also create a possibility window for deeper intervention by reducing urgency, stabilizing a volatile relation, or protecting the capacities required for later participation. Surface intervention therefore has a potentially generative role even when its focal object is immediate manifestation.

The principal methodological risk is recurrence. If the underlying relations and generative conditions remain stable, the manifested problem can return after the surface intervention ends. Repeated surface intervention can then become an implicit maintenance regime. Such a regime may be appropriate when deeper transformation is infeasible, illegitimate, or more harmful, but its recurrent costs and dependencies should be represented explicitly rather than interpreted as evidence that the underlying problem has been resolved.

Surface interventions can also change the field indirectly. Temporary relief can alter expectations, trust, dependency, political attention, or institutional responsibility. A short-term substitute can become a durable infrastructure. A provisional category can become normalized. The depth profile should therefore distinguish the intervention's intended focal depth from consequential changes generated elsewhere in the practical configuration.

A useful design question at this layer is whether the intervention preserves later agency. Surface action can narrow future possibilities if it consumes scarce capacity, establishes lock-in, suppresses diagnostic signals, or converts a temporary response into an unexamined permanent arrangement. Conversely, it can expand later action space by buying time, protecting affected subjects, and maintaining reversibility. Surface intervention should therefore be evaluated through both immediate consequence and the options it leaves available for later praxis.

11.18.2 State Intervention

State intervention changes the current configuration of a represented system while treating the generative rule or transformation architecture as sufficiently stable for the practical task. The distinction from surface intervention is analytical. A surface intervention can modify only a manifested interface, whereas a state intervention can alter variables or configuration components that matter directly to later evolution even though the rule generating subsequent transitions remains unchanged.

Definition 11.325 (State intervention). A *state intervention* is an intervention that changes selected components of the current practical configuration while leaving the represented transformation rule, institutional grammar, or generative architecture approximately fixed over the intervention horizon.

State intervention is natural in models where a current configuration can be distinguished from the rule under which it evolves. Examples include changing a resource stock, staffing level, reserve, access condition, buffer, current allocation, or other state component while assuming that the relations and update mechanisms governing later change remain approximately stable. This can be a powerful and appropriate approximation where the practical horizon is bounded and the generative rule is empirically stable enough for the decision.

The methodological question is how rapidly the altered state is expected to decay, reproduce itself, or be absorbed by unchanged dynamics. A state intervention can produce a durable trajectory change if the new state crosses a threshold, enters another basin, creates a capability, or changes later event reachability. It can also disappear quickly if existing relations and institutions restore the earlier configuration. The distinction should be diagnosed rather than inferred from the apparent magnitude of the initial state change.

State intervention also interacts with event-ordered time. The same state change can have different consequences depending on the historical position at which it occurs. A resource injection before institutional authorization can be unusable, while the same injection after authorization can activate a new branch of action. State intervention should therefore retain the precedence and relational conditions through which a current-state change becomes generatively effective.

Repeated state interventions can reveal a deeper mismatch. If maintaining an acceptable configuration requires recurrent external correction, the method should ask whether the relevant mechanism lies in relations, constraints, capacities, institutions, or rules. The appropriate conclusion is not automatically to intervene more deeply. Recurrent correction can remain preferable where deeper transformation carries disproportionate uncertainty or legitimacy cost. The recurrence nevertheless becomes diagnostic evidence about the limits of the state-level strategy.

11.18.3 Relational Intervention

Relational intervention changes the relation through which subjects, positions, organizations, or other practical objects affect one another. The focal object is therefore not an isolated entity but a dependency, authority relation, exchange relation, trust relation, information interface, recognition relation, care relation, coordination relation, or other typed connection whose organization contributes materially to the practical trajectory.

Definition 11.326 (Relational intervention). A *relational intervention* is an intervention whose primary intended transformation concerns the existence, type, direction, intensity, accessibility, reciprocity, or governance of relations among practical positions.

Relational intervention can change later possibilities even when the attributes of the participating subjects remain initially unchanged. Altering an information interface can redistribute knowledge. Changing an authorization relation can redistribute practical power. Creating a trusted communication channel can generate coordination capacity. Reducing a dependency can make exit or refusal reachable. These consequences illustrate why relational depth differs from state depth: the intervention changes the pathway through which later states are produced.

Relations can be multiplex. Two positions can simultaneously exchange resources,

share information, depend on one another, and occupy an asymmetric authority relation. An intervention that improves one relation can worsen another. Increasing information flow can strengthen coordination while also increasing surveillance. Strengthening accountability can increase answerability while generating administrative burden. The relational target should therefore retain relation type and practical meaning rather than reducing every edge to one scalar intensity.

Relational intervention can also generate new subjects or collective agency. Repeated coordination, mutual recognition, shared vocabulary, or durable collaboration can create a collective capacity that did not previously exist. Conversely, severing a relation can dissolve a previously coherent collective subject. These possibilities connect relational depth to the historical-relational subject architecture developed in Sections 11.7 and 11.13.

The principal governance issue is asymmetry. A relation can be changed by an actor who controls only one endpoint or by an institution whose authority covers some participants more strongly than others. Relational intervention should therefore record affected positions, authority, consent where relevant, exit conditions, and possible redistribution of burden or dependency. A relation that is efficient from one position can be constraining from another.

11.18.4 Historical-Relational Subject Intervention

Historical-relational subject intervention concerns changes to the practical configuration of a subject understood as an event-extended relational object rather than as a point bearing fixed attributes. Its inclusion requires particular care because intervention on a subject can affect capability, recognized standing, internal organization, identity-relevant categories, external relations, and the historical continuity through which the subject participates in later praxis.

Definition 11.327 (Historical-relational subject intervention). *A historical-relational subject intervention* is an intervention that intentionally modifies a subject's capabilities, recognized standing, internal organization, constitutive relations, practical roles, or event-historical configuration in ways expected to alter the subject's later participation in the practical field.

The category includes supportive and enabling forms of intervention. Capability formation, restoration of standing, removal of disabling classification, repair of a damaged relation, creation of protected voice, or strengthening of internal coordination can all transform the subject's later action space. Subject-level intervention therefore need not mean direct manipulation of preference or identity. It can concern the relational conditions under which the subject can act, learn, refuse, coordinate, or revise its own orientation.

The historical dimension is essential. A subject's present configuration can contain accumulated commitments, injuries, skills, institutional positions, expectations, and recognized events. An intervention that appears equivalent at the level of present-state variables can have different consequences for subjects with different histories. Where a partial-order or labeled 2-complex representation is useful, subject intervention can be modeled as addition, removal, relabeling, or reorganization of event-relational structure. Other historical or interpretive representations may be preferable where formal event structure would conceal meaning.

Subject intervention also raises a stronger legitimacy burden than many state inter-

ventions because the intervention can alter the conditions of agency through which future consent or judgment is expressed. A programme that builds capability can expand agency; a classification regime can narrow recognition and available actions; an institutional process can reshape self-understanding or dependency. The method should therefore distinguish support for agency from substitution for agency and preserve contestability where the intervention modifies subject standing or identity-relevant categories.

There is also a risk of mislocating structural problems within subjects. When the generative mechanism operates mainly through institutional rules, field-level incentives, exclusionary relations, or infrastructural constraints, attempting to transform the affected subject can reproduce the very asymmetry that generated the problem. Historical-relational subject intervention should therefore be paired with the scale-mismatch analysis of Section 11.17 and the target architecture of Section 11.15.

11.18.5 Structural Intervention

Structural intervention modifies recurrent organization among positions, relations, events, or flows that persists across particular local states. A structure can be represented as a topology, role configuration, recurring dependency pattern, higher-order relation, institutional arrangement, spatial organization, or another stable pattern through which local events are conditioned. Structural depth therefore concerns the organization that makes certain local states repeatedly likely, reachable, or difficult to escape.

Definition 11.328 (Structural intervention). A *structural intervention* is an intervention intended to transform a recurrent organization of positions, relations, flows, or dependencies whose persistence materially shapes multiple later practical states or histories.

Structural intervention differs from relational intervention by scope of organization rather than necessarily by scale. One relation can be changed without altering the wider structure in which similar relations are repeatedly generated. Conversely, modifying a structural interface can alter many local relations without targeting each one separately. The distinction is model-relative: the analyst should state what counts as recurrent organization and how the represented structure is connected to observed practical conditions.

A structural intervention can involve topology, access pathways, role distributions, coordination architecture, dependency concentration, infrastructure, or higher-order rules of association. Its effect can propagate widely because several local processes rely on the same structure. This wider reach increases both potential leverage and the cost of representational error. If the diagnosed structure is only a visible correlate rather than a generative mechanism, deep structural intervention can redistribute harm without resolving the practical condition.

Structures can also carry useful capacity. Repeated relations can support trust, memory, specialization, care, redundancy, or rapid coordination. Intervention should therefore identify both the burdens and capabilities reproduced by the structure. A redesign that removes a harmful dependency while destroying local knowledge or repair capacity can produce a formally cleaner structure with lower practical generativity.

Structural intervention should also preserve historical provenance. Recurrent or-

ganization can be the cumulative result of earlier decisions and adaptations rather than one deliberately designed system. This can make reversal difficult: actors have invested, learned, and organized around the structure. A structural transition plan should therefore represent intermediate configurations, displaced functions, and the capacities required to maintain continuity while the structure changes.

11.18.6 Constraint Intervention

Constraint intervention changes conditions that limit, channel, protect, or otherwise shape the reachable actions and histories of practical subjects. The objective can be to remove a disabling constraint, weaken a bottleneck, create a protective boundary, or redesign how constraints are distributed across positions. The method should retain the dual character of constraints: they can restrict agency while also preserving safety, rights, reliability, coordination, or ecological and institutional integrity.

Definition 11.329 (Constraint intervention). A *constraint intervention* is an intervention that modifies a condition limiting or channeling practical reachability, including the creation, relaxation, redistribution, substitution, or redesign of that condition.

Removing one constraint can expose another. A formal authorization barrier can be removed while financial, informational, relational, or capability constraints continue to block effective action. The intervention should therefore use the constraint-configuration analysis developed in Section 11.2 rather than treating constraints as independent obstacles.

Constraint substitution is especially important. Relaxing a regulatory constraint can increase dependence on private gatekeeping. Removing a procedural burden can transfer verification work to affected subjects. Tightening a safety rule can reduce one risk while creating access barriers elsewhere. The appropriate unit of evaluation is therefore the transformed constraint configuration and its distribution, not only the focal constraint.

Protective constraints can be generative. A protected right, safety boundary, or procedural requirement can preserve trust and future participation. A reserve requirement can maintain reversibility. A limit on extraction can preserve regenerative capacity. Constraint intervention therefore should specify which restrictions are regarded as burdens, which are regarded as constitutive or protective, and how those interpretations were established.

Constraints can also be historical. A present restriction can persist because earlier investments, classifications, or institutional arrangements narrowed the action space. Constraint intervention can accordingly require work on the history or structure that sustains the restriction, rather than only its current manifestation. The depth profile should identify whether the focal constraint is directly modifiable or is an expression of a deeper relation, structure, institution, or rule.

11.18.7 Capacity Intervention

Capacity intervention aims to create, restore, distribute, combine, or sustain the ability of subjects or institutions to perform practical functions. Relevant capacities include sensing, interpretation, deliberation, decision, coordination, implementation, maintenance, repair, learning, contestation, and revision. Capacity intervention is therefore generative by design: it changes what later actions can become reachable.

Definition 11.330 (Capacity intervention). A *capacity intervention* is an intervention intended to create, restore, distribute, combine, or sustain practical abilities through which subjects, collectives, or institutions can later recognize, choose, execute, maintain, repair, or revise action.

Capacity should remain distinct from resource possession. Resources can contribute to capacity, but they require activation through knowledge, authority, relations, infrastructure, timing, and coordination. A training programme can increase skill without creating opportunity to use it. New information can remain ineffective without decision rights. Funding can remain idle without implementation capability. The method should therefore identify the activation pathway through which the intervention is expected to become usable capacity.

Capacity intervention can also change power. Giving one position analytical capability, mobility, legal standing, technical infrastructure, or coordination resources can alter dependency and bargaining relations. Capacity distribution should therefore be evaluated together with participation, responsibility, and justice. A system that increases total capability while concentrating the ability to define problems or control infrastructure can become more productive and less contestable at the same time.

Capacity can decay. Skills atrophy, organizations lose memory, infrastructure requires maintenance, and trust can deteriorate. A capacity intervention should therefore specify maintenance and regeneration conditions rather than recording only initial acquisition. This is especially important for long-horizon praxis, where the capacity to adapt and repair can matter more than peak initial performance.

Capacity intervention can also be intentionally enabling rather than directive. Instead of determining a specific downstream action, it can expand the capability of affected subjects to generate, compare, and revise their own actions. Such interventions are especially relevant where uncertainty is deep or local knowledge is distributed. Their evaluation should include the future action-space effects they create, not only immediate task performance.

11.18.8 Institutional Intervention

Institutional intervention changes durable arrangements of mandate, role, authority, routine, accountability, memory, classification, and coordination through which collective praxis is organized. It can therefore alter both present behavior and the mechanisms by which later decisions are produced, implemented, reviewed, and remembered.

Definition 11.331 (Institutional intervention). An *institutional intervention* is an intervention intended to transform durable arrangements of mandate, authority, role, procedure, accountability, memory, classification, or coordination that organize repeated practical action across time.

Institutional intervention should distinguish formal design from enacted configuration. A revised mandate can leave routines unchanged. A new reporting procedure can generate extensive records without creating answerability. A participatory body can exist formally while lacking agenda-setting power or protected voice. Institutional depth therefore concerns changes in effective practical organization as well as formal rules.

Institutional transformation can have long historical reach because later actors inherit its records, categories, responsibilities, infrastructures, and default procedures. The event-ordered architecture is useful here: institutional change is often an extended history composed of authorization, implementation, adaptation, conflict, reinterpretation, maintenance, and later revision rather than a single dated event. Different branches can emerge when local organizations enact the same formal reform differently.

Institutional intervention can also redistribute practical memory. Merging organizations, changing reporting systems, outsourcing functions, or replacing a professional community can sever memory interfaces even while improving present efficiency. A transition plan should therefore preserve reasons, unresolved uncertainty, responsibility, and knowledge needed by later actors. Institutional forgetting can turn a reversible reform into effective lock-in because later subjects can no longer reconstruct the conditions under which reversal was contemplated.

The legitimacy burden also rises when institutional intervention changes who can decide for whom, who is recognized, or who bears accountability. Authorization, participation, representation, and contestability should therefore be part of the intervention design rather than post-hoc governance additions. The deeper the institutional transformation, the more important it becomes to specify whose practical standing is altered and through what authority.

11.18.9 Observation and Representation Intervention

Observation and representation intervention changes the categories, indicators, data practices, classifications, maps, models, visibility rules, or interpretive procedures through which a practical field becomes knowable and governable. This layer is especially important under the revised epistemic-event architecture because representations can become performative when their recognition or institutional uptake changes the field they describe.

Definition 11.332 (Observation-regime intervention). An *observation-regime intervention* is an intervention that modifies how practical events, subjects, relations, states, or histories are selected, classified, measured, represented, communicated, or made institutionally visible.

Changing an indicator can redirect organizational attention. Recognizing a previously invisible category can create standing or eligibility. A new map can expose a dependency and enable coordination. A ranking can alter incentives and strategic behavior. A legal or administrative classification can generate rights and duties. These cases show why observation and representation can be relatively deep interventions even where the immediate material configuration appears unchanged.

The typed distinction from Section 11.4 should remain explicit. A readout maps a practical configuration into a representation. Institutional uptake can then couple that representation to a transformation of the field. The intervention can therefore concern the observation architecture, the coupling architecture, or both. Treating these stages as identical would obscure whether the change arose from improved knowledge, from performative recognition, or from the institutional transformation triggered by that recognition.

Representation intervention also carries risks of exclusion and stabilization. New categories can make previously invisible conditions legible while simultaneously fix-

ing heterogeneous subjects into administratively convenient classes. Indicators can support accountability while narrowing attention toward what is measurable. Models can improve coordination while concentrating interpretive authority. The method should therefore record representation remainders, affected positions, and contestability pathways.

Observation regimes also change evidence production. Once actors learn how they are measured, behavior and reporting can adapt. A monitoring system can therefore create new epistemic events and alter later data-generating processes. This makes versioning essential: evidence produced before and after a representation intervention may not be directly comparable without reconstructing the changed observation regime.

11.18.10 Rule Intervention

Rule intervention changes the transformation, update, permission, composition, or admissibility rules through which later practical configurations are generated. Section 11.15 introduced rules as intervention targets. The present subsection places rule transformation within the depth architecture and clarifies why rule-level intervention often carries a larger downstream reach than changing one present state or relation.

Definition 11.333 (Rule-depth intervention). A *rule-depth intervention* is an intervention that intentionally changes a represented transformation rule, update procedure, permission structure, composition law, or admissibility condition governing how later practical states, actions, relations, or histories can be generated.

A rule-level change can affect many later events because it changes the conditions under which those events become reachable. Changing an eligibility rule can reorganize access across an entire population of later cases. Changing an algorithmic update rule can alter future classifications. Revising an institutional authorization process can redistribute decision power across subsequent histories. Modifying the composition order of interventions can change the field on which later transformations operate.

Rule intervention can also change the history space rather than merely reweight histories already represented. A new permission can create branches that did not previously exist. A prohibition can foreclose an entire family of actions. A revised institutional process can generate new subject roles or new epistemic events. This is why rule depth connects directly to the history-space architecture of Sections 11.4–11.8.

The greater reach of rule intervention creates a demanding epistemic problem. Errors in a rule can propagate across many downstream cases before they become visible. Local success under one context may not justify field-wide rule revision where transportability is uncertain. Rule intervention should therefore make scope, validity region, monitoring, fallback conditions, and authority explicit. Staged or modular rule changes can sometimes preserve learning and reversibility better than immediate universalization.

Rule intervention also creates reflexive effects. Actors learn rules, reorganize around them, exploit them, resist them, and develop institutions specialized to them. The effective rule after adaptation can therefore differ from the formal rule initially enacted. Evaluation should include these co-evolutionary consequences rather than

examining only whether implementation matched the original specification.

11.18.11 Deep Intervention Risk

Deep intervention can create large generative leverage because it changes conditions through which many later events and actions are produced. The same leverage can amplify diagnostic error, legitimacy failure, unintended consequence, path dependence, and loss of reversibility. Depth therefore creates a distinctive practical burden: the intervention reaches farther into the architecture that later actors inherit.

Definition 11.334 (Deep-intervention risk profile). A *deep-intervention risk profile* records the epistemic uncertainty, affected positions, reversibility, propagation pathways, option-space effects, institutional and subject transformation, legitimacy conditions, repair capacity, and possible long-horizon consequences associated with intervening at the selected generative depth.

Several risk dimensions deserve separate treatment. *Diagnostic depth risk* arises when the represented generative mechanism is mistaken. *Propagation risk* arises when a deep change spreads across relations or histories farther than intended. *Lock-in risk* arises when later subjects, institutions, and infrastructures adapt around the intervention. *Agency risk* arises when subject or institutional transformation alters the practical standing of those expected to contest or revise the intervention. *Epistemic risk* arises when the intervention changes the observation regime in ways that make its own consequences harder to detect. *repair risk* arises when the intervention removes the capacities required to reverse or compensate for harm.

Deep intervention can also destroy useful generativity together with harmful structure. A relation that reproduces dependency can simultaneously carry care or knowledge. An institution that imposes burdens can preserve memory and coordination. A rule that constrains access can also protect safety. A structural redesign can remove redundancy that appeared inefficient under the original performance metric. The intervention should therefore identify functions worth preserving and, where possible, create replacement capacity before dismantling the structure that currently provides them.

The depth decision should be proportionate to practical warrant. Greater expected leverage increases the importance of mechanism evidence, affected-subject participation, authority, monitoring, reversibility, and repair capacity. Yet proportionality does not mean that deep intervention always requires complete knowledge. In urgent situations a deeper action can be justified where shallow alternatives cannot protect against severe and accumulating harm. The methodological requirement is to make the residual uncertainty and protection architecture commensurate with the depth of commitment.

Definition 11.335 (Depth proportionality). *Depth proportionality* is the alignment between the generative depth of an intervention and the strength of its diagnostic support, legitimate authority, participation, reversibility, monitoring, repair capacity, and protection of affected positions, given the consequences of both intervention and continued inaction.

Depth proportionality also leaves room for deliberately shallow design. A reversible state intervention can be preferable to a deep institutional reform when the mechanism remains uncertain. A temporary surface intervention can preserve affected subjects while participatory diagnosis continues. A capacity intervention

can generate later options without prematurely fixing a rule. In other cases, repeated shallow interventions can accumulate into an opaque permanent regime and should be compared with a more explicit structural or institutional transformation. The relative merits depend on the practical field, not on an abstract preference for depth.

A final concern is *depth coupling*. An intervention intended at one depth can trigger changes at another. A representation intervention can become a rule intervention when a classification is embedded in authorization. A capacity intervention can become a relational intervention when newly capable actors renegotiate dependencies. A structural intervention can generate subject transformation through altered roles and histories. The depth profile should therefore be revised when consequential coupling crosses the original design boundary.

Proposition 11.336 (Intervention-depth adequacy). *Intervention depth is practically adequate to the extent that the selected depth corresponds to a defensible account of the generative mechanism, preserves or replaces valuable capacities carried by the transformed configuration, and is matched by proportionate authority, participation, uncertainty management, reversibility, monitoring, and repair arrangements.*

Proposition 11.336 closes the separation of target, timing, scale, and depth developed across Sections 11.15–11.18. These dimensions now provide inputs to a more integrated design problem. The next section therefore turns to *intervention design*, where objective, target, mechanism, epistemic-event architecture, enabling conditions, expected histories, monitoring, revision, and exit are assembled into one practical intervention architecture.

11.19 Situated Intervention Design

The role of this section is to specify intervention design at the meta-methodological level after target, timing, scale, and depth have been treated separately. Its objective is to show how these dimensions can be composed into a context-sensitive practical architecture without turning one intervention template into a universal sequence. The discussion proceeds through situated composition, selective relevance of design dimensions, the relation among orientation, target, and mechanism, enabling and constraining conditions, effects on history and possibility spaces, embedded monitoring and revision, provenance and responsibility, and proportionate design depth. The method is architectural and plural: an intervention design can be formal, institutional, participatory, historical, legal, computational, qualitative, or mixed according to the practical field.

Intervention design is therefore understood as a problem of composition. Different fields require different design objects. A small reversible adjustment can require little more than a clearly specified action, responsible position, observation route, and stopping condition. A deep institutional transformation can require historical reconstruction, multiple mechanisms, participatory governance, legal authority, formal models, staged implementation, independent monitoring, repair capacity, and long-duration exit obligations. The framework should help identify which dimensions matter and how they are related; it should not force every intervention to fill the same checklist.

Definition 11.337 (Situated intervention design). *A situated intervention design is a revisable composition of the practical orientations, intervention objects, mechanisms, timing, scale, depth, enabling conditions, constraints, anticipated histories, observa-*

Table 11.19: Intervention-design dimensions as a context-sensitive analytical repertoire.

Design dimension	Analytical object	Reason for inclusion	Possible form
Practical orientation	Valued direction, protection, obligation, or exploratory purpose	Clarifies what gives the intervention practical direction	Qualitative commitment, target, protected condition, partial order
Intervention object	State, relation, subject history, institution, rule, field, capacity, representation	Identifies where practical transformation is directed	Target map, relational description, institutional locus
Mechanism	Proposed pathway connecting intervention to later change	Makes the generative hypothesis inspectable	Narrative mechanism, causal model, process map, simulation
Timing / scale / depth	Temporal position, practical resolution, transformation depth	Locates the intervention within its operating field	Stage plan, multi-scale map, depth profile
Enabling and constraining conditions	Capacities, authority, resources, protections, dependencies	Identifies conditions affecting viability and admissibility	Institutional analysis, legal constraints, capacity profile
History and possibility effects	Expected, adverse, alternative, and option-space consequences	Extends design beyond one forecasted outcome	Scenario family, historical analysis, option profile
Observation and learning	Monitoring, feedback, epistemic events, evaluation	Connects implementation to later revision	Indicator system, qualitative inquiry, participatory review
Responsibility and contestability	Authority, duties, affected positions, challenge routes	Preserves accountability across distributed action	Responsibility map, review procedure, appeal channel
Revision / exit	Reopening, repair, rollback, termination, residual obligation	Preserves capacity to alter or end the intervention	Trigger conditions, revision rule, exit architecture

tion arrangements, responsibility relations, revision pathways, and exit conditions that are materially relevant to a specified intervention in its historical-relational field.

The phrase *materially relevant* is central. A design dimension belongs in the intervention architecture when omitting it would materially weaken practical understanding, accountability, protection, learning, or capacity for revision. The set of relevant dimensions can therefore differ across cases and can expand after the intervention begins.

Table 11.19 presents a repertoire of design dimensions. The table is not a mandatory form. Its function is to make possible interfaces visible so that a project can select and document those needed for its own field.

The repertoire in Table 11.19 also supports proportionality. A dimension can be represented lightly when consequence is small and strongly bounded. The same di-

mension can require extensive analysis when the intervention is deep, long-duration, difficult to reverse, distributively concentrated, or dependent on uncertain mechanisms.

11.19.1 Design as Situated Composition

A situated design begins with the practical field rather than with a preselected form. The field can already contain interventions, institutional routines, inherited obligations, competing authorities, affected subjects, and historical dependencies. Designing action therefore often means composing a change into an existing architecture rather than creating a discrete instrument on an empty background.

Definition 11.338 (Design configuration). A *design configuration* is the current version of the intervention architecture, including the subset of design dimensions judged materially relevant, the relations among them, their evidential and normative provenance, and the conditions under which the configuration should be reopened.

The design configuration can be represented through a document, process map, formal model, institutional protocol, participatory agreement, legal instrument, or combination of these. Its adequacy depends on whether the representation supports the decisions being made. A universal diagram would be less informative than a local representation that preserves the field's actual relations.

Design composition can also be iterative. Mechanism analysis can reveal a missing enabling capacity; participatory inquiry can identify an affected position; legal review can change the action set; a pilot can reveal an unanticipated dependency. The configuration should therefore permit addition, removal, or reinterpretation of design dimensions without treating every change as failure of the original method.

11.19.2 Selective Relevance of Design Dimensions

The design repertoire is selective by construction. Target, timing, scale, depth, monitoring, and exit are frequently important, but their required resolution differs. Some interventions have no single target because they seek to create a coordination field or open a deliberative process. Some have no precise endpoint because their purpose is capability formation. Some are principally protective and therefore organize around constraints rather than outcome maximization.

Definition 11.339 (Design-relevance test). A *design-relevance test* asks whether explicit representation of a candidate design dimension would materially change understanding of mechanism, affected positions, authority, consequence, reversibility, learning, or responsibility for the intervention under consideration.

The test creates a practical reason for inclusion. A detailed exit plan can be essential for a temporary infrastructure on which subjects can become dependent and unnecessary for a one-time informational clarification. A formal mechanism model can be useful for a complex feedback intervention and excessive for a simple administrative correction. A participatory design process can be central where affected meanings and consequences are weakly represented by existing institutions.

Selective relevance also protects the meta-framework from procedural inflation. Methodological completeness should not be measured by the number of boxes completed. It should be measured by the fit between the design architecture and the prac-

tical relations that can materially affect action and consequence.

11.19.3 Orientation, Intervention Object, and Mechanism

Practical orientation, intervention object, and mechanism form a central but non-universal design relation. The orientation identifies the direction or protection that gives action meaning. The intervention object identifies what part of the field is being acted upon. The mechanism states how the action is expected to contribute to change. Each can remain plural or provisional.

A mechanism can be causal, institutional, relational, informational, legal, technological, symbolic, or mixed. It can act by relaxing a constraint, changing an incentive, generating a capacity, reconfiguring a relation, altering a rule, creating redundancy, redistributing authority, changing a representation, or opening a new action pathway. The intervention architecture should make the mechanism explicit to the degree needed for monitoring and learning.

Definition 11.340 (Mechanism-orientation alignment). *Mechanism-orientation alignment* is the documented relation between a practical orientation and the proposed transformation pathway through which an intervention is expected to contribute to that orientation within the specified field.

Alignment is an object of inquiry, not a guarantee of success. An intervention can realize its immediate mechanism while generating consequences that weaken the broader orientation. A classification can increase administrative coordination while reducing contestability. A capacity intervention can improve performance while creating dependency. Design therefore connects local mechanism to broader history-space effects.

11.19.4 Enabling and Constraining Conditions

Interventions depend on conditions that permit, shape, or limit their operation. These can include authority, resources, institutional competence, infrastructure, trust, legal permission, data access, knowledge, coordination, ecological conditions, technical interoperability, or social acceptance. Some conditions should be created before intervention; others can be generated through the intervention itself.

Constraints also have heterogeneous meanings. A material limit, legal protection, safety condition, budget, right, ecological boundary, institutional rule, and historical obligation can all restrict the available action space while carrying different normative and practical status. Section 11.3 treats these differences within the evaluative frame, and Section 11.12 shows how some can enter formal models. Intervention design should preserve their meanings when they are combined.

Definition 11.341 (Condition architecture). An *intervention condition architecture* records the enabling capacities, dependencies, authority relations, protections, material constraints, and institutional conditions whose presence or absence materially affects whether the intervention can operate as intended.

A condition architecture can reveal that the direct target is secondary to capability formation. An intervention can become viable only after training, institutional recognition, data infrastructure, trust repair, legal authorization, or coordination capacity has been created. In these cases, the design should represent the generative

conditions as part of the intervention history.

11.19.5 History-Space and Action-Space Effects

An intervention can change more than the immediate outcome. It can create or close future actions, alter dependencies, reshape expectations, stabilize categories, change institutions, or modify the accessibility of later histories. Design therefore benefits from examining second-order effects on history and possibility spaces where these are materially relevant.

The analysis can use scenario families, historical interpretation, formal transition models, participatory anticipation, or other methods. A design does not need to enumerate every possible future. It should represent the histories capable of changing the practical judgment being made: expected pathways, important adverse pathways, transformative possibilities, and cases in which the assumed mechanism fails.

Definition 11.342 (Possibility-space effect). A *possibility-space effect* is a change in the accessibility, feasibility, authorization, cost, or practical meaning of future actions or histories generated partly through an intervention or its institutional uptake.

Possibility-space analysis is particularly relevant when interventions create infrastructure, categories, dependencies, irreversible investments, institutional precedent, or new capabilities. A favorable immediate result can coexist with long-horizon foreclosure. An initially modest intervention can also generate capacities that make previously unreachable paths accessible.

11.19.6 Observation, Revision, and Exit as Embedded Dimensions

Monitoring, revision, and exit can be designed from the beginning when their later feasibility depends on capacities or records that must be preserved during implementation. A rollback option can require technical modularity. Later evaluation can require a pre-intervention record. Contestable revision can require a governance body. Exit from a temporary service can require replacement capacity.

This does not imply that every intervention needs a detailed monitoring protocol before action. Emergency or exploratory action can begin with limited information. The design question is whether the absence of an observation, revision, or exit arrangement materially reduces the ability to detect harm, learn, repair, or preserve responsibility at the current level of commitment.

Definition 11.343 (Embedded revisability). *Embedded revisability* is the extent to which an intervention preserves the practical, epistemic, institutional, and material conditions needed to reconsider, alter, repair, narrow, terminate, or transfer the intervention as later history unfolds.

Sections 11.21–11.25 develop monitoring, feedback, evaluation, repair, exit, and rollback in detail. The present section establishes only their design-level status: they are possible components of intervention composition when later adaptation depends on them.

11.19.7 Provenance, Responsibility, and Contestability

Intervention design distributes practical authority. Different actors can diagnose, model, authorize, implement, monitor, evaluate, fund, contest, or experience the intervention. A design becomes difficult to govern when these roles are distributed without a visible responsibility architecture.

Definition 11.344 (Design-responsibility map). A *design-responsibility map* records the materially relevant roles of authorization, implementation, epistemic judgment, monitoring, review, repair, communication, and consequence management together with the relations through which those responsibilities can be exercised and contested.

Responsibility can remain shared without becoming vacant. A model can inform a recommendation while an institution retains authorization responsibility. A contractor can implement part of an intervention while the commissioning body retains duties concerning monitoring or remedy. A participatory body can shape design without carrying liabilities that exceed its authority. Making these relations explicit supports later analysis of distributed and machine-mediated decision support.

Contestability also belongs to design where representations or decisions can materially affect subjects. Challenge can concern factual error, category mismatch, model assumption, procedural exclusion, legal standing, or normative disagreement. Different challenge types require different institutions. A technically auditable model does not by itself provide a meaningful route for contesting the values embedded in its use.

11.19.8 Proportionate Design Depth

The depth of design should reflect the depth of practical commitment. A bounded and reversible action can be governed through a compact record. A deep, long-duration, difficult-to-reverse intervention can justify more extensive historical reconstruction, model comparison, participation, independent review, monitoring, repair planning, and residual-obligation analysis.

Definition 11.345 (Proportionate design depth). *Proportionate design depth* is the degree of explicit analysis, documentation, review, and revisability devoted to an intervention in relation to its scale, duration, uncertainty, distributive concentration, dependency generation, institutional depth, and reversibility.

Proportionality prevents the meta-framework from becoming administratively maximalist. Additional procedure can itself impose cost, delay urgent action, concentrate expertise, or exclude actors unable to participate in complex documentation. The design architecture should therefore justify both what it includes and what it deliberately leaves implicit.

Proposition 11.346 (Meta-level intervention-design adequacy). A *situated intervention design* is *methodologically adequate* to the extent that the design dimensions materially relevant to its field are represented with sufficient provenance, relational context, responsibility, protection, and revisability for the commitment being made, while dimensions with little practical relevance remain available without becoming mandatory procedural requirements.

Proposition 11.346 makes the status of Section 11.19 explicit. The section provides a repertoire and a composition logic. It does not define a universal intervention template. Section 11.20 develops experimental and pilot intervention as one possible

mode of practical learning within this broader architecture.

11.20 Experimental and Pilot Intervention

Section 11.19 treated intervention design as a situated composition drawn from a context-sensitive repertoire of orientations, intervention objects, mechanisms, temporal and scalar dimensions, enabling conditions, history-space effects, observation arrangements, responsibility relations, revision pathways, and exit conditions. The present section develops the next methodological step: bounded practical contact with the field through pilots and experimental arrangements. Its role is to specify how an intervention can be introduced under controlled or deliberately limited conditions so that feasibility, mechanism, implementation, observation, consequence, and revision capacity can be learned without treating experimentation as epistemically neutral or ethically costless. Its objective is to distinguish several forms of practical experimentation, explain how intervention-generated evidence should be interpreted, preserve the distinction between observation and performative transformation, develop reversibility and protection conditions, and clarify what can and cannot be inferred when moving from a bounded experiment toward wider implementation. The discussion proceeds through pilot design, field, natural, policy, and institutional experiments, intervention-generated evidence, performative observation, reversible experimentation, ethical limits, and scaling after experiment.

Definition 11.347 (Experimental intervention). An *experimental intervention* is a deliberately structured practical transformation, or a structured comparison around a transformation, whose design preserves explicit questions about feasibility, mechanism, implementation, consequence, or transfer and whose observation architecture is organized so that the resulting practical history can revise later judgment and action.

Experimental intervention is broader than a laboratory-style manipulation. It can include field trials, policy pilots, staged institutional reforms, naturally occurring contrasts, or other bounded practical arrangements in which observed variation can inform later praxis. The category is functional rather than disciplinary: what matters is the relation among intervention, comparison, observation, practical consequence, and revision.

The boundedness of an experiment should not be confused with absence of consequence. A pilot can change expectations, create temporary rights or dependencies, generate new categories, mobilize resources, establish institutional precedents, alter trust, or open and foreclose later action paths. It can also change the subjects and institutions that participate in the experiment. Experimental design should therefore inherit the responsibility, justice, participation, and closure requirements developed in Chapter 10 rather than operate under a presumption of harmlessness.

Definition 11.348 (Experimental intervention dossier). An *experimental intervention dossier* is the versioned record of the experimental objective, practical and epistemic questions, target, intervention mechanism, event-order architecture, comparison structure, affected positions, exposure, observation regime, expected and alternative histories, reversibility provisions, ethical protections, decision gates, revision rules, exit conditions, and conditions for transfer or wider implementation.

Table 11.20 summarizes the methodological architecture. The dimensions should

Table 11.20: Methodological dimensions of experimental and pilot intervention.

Dimension	Primary methodological object	Characteristic question
Pilot design	Bounded practical commitment	What can be learned while limiting exposure, lock-in, and irreversible consequence?
Field experiment	Designed variation in an operating field	Which practical differences can be attributed under real implementation conditions?
Natural experiment	Historically generated comparison	Which contrast is informative without treating naturally occurring variation as automatically exogenous?
Policy experiment	Rule, programme, or public-action variation	How do implementation, response, distribution, and legitimacy alter the experimental history?
Institutional experiment	Roles, mandates, routines, or governance arrangements	How does the institution adapt, reinterpret, and reproduce the experimental design?
Intervention-generated evidence	Evidence produced through practical transformation	What was revealed, created, activated, or obscured by the intervention itself?
Performative observation	Observation that can alter the field	How do measurement, classification, disclosure, and attention change later histories?
Reversible experimentation	Rollback and repair capacity	Which commitments can be reversed, and which residues remain after reversal?
Ethical limits	Exposure, burden, standing, and protection	Which experimental commitments remain admissible under uncertainty and unequal power?
Scaling	Transfer into a changed scale and field	Which mechanism, capability, protections, and history structure survive or transform beyond the experiment?

not be interpreted as a linear checklist. A pilot can contain policy and institutional experimentation; field observation can be performative; ethical constraints can determine experimental scale and depth; and the possibility of later scaling should shape which mechanisms and enabling conditions are observed from the beginning.

11.20.1 Pilot Design

A pilot is a bounded intervention used to learn about practical feasibility, mechanism, implementation, affected positions, institutional response, observation, and revision

before deeper or wider commitment. Its value lies in creating a deliberately limited practical history whose consequences can inform later action. A pilot should therefore be designed as an intervention in its own right rather than as an administratively smaller copy of an eventual programme.

Definition 11.349 (Pilot intervention). A *pilot intervention* is a bounded, monitored, and revisable practical intervention whose scale, duration, depth, exposure, institutional commitment, or action-space effect is intentionally limited so that selected practical and epistemic questions can be examined before a later commitment is made.

Pilot boundedness can concern several dimensions. A pilot can be limited geographically, institutionally, relationally, temporally, by participant exposure, by intervention depth, by authority, or by the range of histories it is permitted to generate. These dimensions need not coincide. A geographically small pilot can still be institutionally deep if it changes legal standing, durable classification, or organizational rules. Conversely, a wide informational intervention can remain shallow if it leaves authority and institutional relations unchanged.

The pilot should begin with explicit questions. These can concern whether an enabling condition exists, whether a proposed relation can be sustained, whether an observation regime is usable, whether an institution can implement the design, whether affected subjects experience an omitted burden, whether a mechanism appears to operate, or whether rollback remains feasible after real contact with the field. An experiment that produces abundant data without a defined practical question can still generate information, but its relation to later commitment becomes difficult to reconstruct.

Definition 11.350 (Pilot envelope). A *pilot envelope* specifies the permitted scale, duration, depth, affected positions, exposure, event-order boundaries, resource commitment, authority, observation regime, reversibility reserve, and conditions under which the pilot may continue, expand, pause, narrow, or terminate.

The pilot envelope should include event-order conditions. Under the temporal architecture of Section 11.16, some enabling or protective events may need to precede intervention events. Training can need to precede delegated authority; consent or institutional authorization can need to precede data collection; fallback capacity can need to exist before a reversible technical intervention begins. Other events can remain unordered where no relevant precedence is asserted. Clock time can be added where operational synchronization is necessary, but it need not define the underlying historical structure.

A pilot also needs a pre-specified relation to later decision. Successful implementation does not automatically imply scale-up. A pilot can support continuation, modification, additional inquiry, bounded extension, or termination. The decision gate after a pilot should therefore refer to mechanism evidence, implementation capacity, adverse and distributional consequences, reversibility, residual uncertainty, and whether the pilot itself changed the field in ways that make the original comparison obsolete.

Finally, pilot design should preserve a counterfactual memory. Once participants, institutions, and observers experience the pilot, the pre-pilot field may no longer be recoverable. The dossier should record the earlier action space, institutional configuration, observation regime, and affected positions sufficiently well that later evaluation can distinguish changes created by the pilot from conditions that preceded it.

11.20.2 Field Experiment

A field experiment introduces designed variation within an operating practical environment. Its methodological attraction is that the intervention occurs under conditions closer to those in which later action may actually operate. Its methodological difficulty is that real fields contain strategic response, institutional adaptation, interference among units, heterogeneous implementation, and performative observation. The design should therefore preserve these relations rather than treat them only as deviations from ideal experimental control.

Definition 11.351 (Field experimental configuration). A *field experimental configuration* is a practical arrangement in which selected intervention conditions or assignments are deliberately varied within an operating field and linked to an observation and comparison architecture designed to support bounded causal, mechanistic, implementation, or consequence-related inference.

Assignment or intervention contrast can strengthen causal interpretation under appropriate conditions, but the relevant inferential object should remain explicit. A field experiment can estimate a local treatment contrast without establishing the deeper generative mechanism, transferability, institutional sustainability, or long-horizon effect. Conversely, a heterogeneous response that weakens a simple average effect can reveal a relational or institutional structure that is practically more important than the aggregate estimate.

Interference deserves particular attention in GR. If one participant's exposure changes another participant's behavior; if information spreads through a network, or if institutional staff reorganize around the intervention, the field does not decompose into independent units. Such interference can be modeled where appropriate through networks, fields, higher-order relations, or clustered structures. It can also be treated qualitatively when the formal assumptions required for a quantitative model are unsupported.

Field experiments can generate epistemic events outside the intended intervention. Participants can infer the purpose of the experiment; staff can change behavior because they know they are observed; public communication can alter expectations; classification into treatment or comparison categories can acquire social meaning. The experimental field is therefore historically transformed by the experiment's existence. The design should record these transformations and interpret the resulting estimates within that changed field.

The practical consequence of a field experiment also extends beyond estimation. The intervention may generate skills, trust, resentment, routines, infrastructure, expectations, or claims to continuation. A later decision to stop or scale the experiment should account for these generated conditions. Experimental closure is thus a practical event with residual consequences, not merely the end of data collection.

11.20.3 Natural Experiment

A natural experiment differs from a designed field experiment because the investigator does not create the relevant variation solely for experimental identification. A historical, administrative, environmental, institutional, or other process generates a contrast that can potentially support causal or comparative inference. The methodological opportunity arises from the structure of the event history; the principal dan-

ger is treating a convenient contrast as though its assignment mechanism were automatically exogenous or random.

Definition 11.352 (Natural-experimental contrast). A *natural-experimental contrast* is an historically generated difference in exposure, timing, eligibility, assignment, or institutional condition whose generative pathway can be reconstructed sufficiently to support a bounded comparison without representing the investigator as the source of the variation.

The first task is therefore historical reconstruction. The event that creates the contrast should be situated within its predecessor relations, institutional process, affected positions, and possible anticipatory responses. If actors could influence assignment, move across the boundary, adapt before exposure, or receive correlated interventions, the contrast can embody selection and relational response that undermine a simple causal interpretation.

Natural experiments can be especially useful in an event-ordered representation. Rather than beginning from a calendar discontinuity alone, the analysis can ask which events precede exposure, which events become incomparable across branches, and which later outcomes depend on the institutional path that generated the contrast. A date or threshold can be operationally useful while remaining only one label on the deeper event history.

A natural-experimental comparison should also distinguish identification from transport. A historically specific event can produce a credible local contrast while remaining difficult to generalize to another institution, scale, or historical field. The mechanism that created the variation can itself be unique. Transfer therefore requires the same historical, relational, and institutional scrutiny developed in Sections 11.13 and 11.17.

Because the investigator did not create the initiating event, the ethical architecture differs from deliberate experimentation but does not disappear. Data use, interpretation, privacy, representation, communication, and downstream decisions can still generate burdens and performative effects. Natural occurrence does not make later research or policy use normatively neutral.

11.20.4 Policy Experiment

Policy experimentation applies bounded variation, staged implementation, or deliberately revisable design to rules, programmes, resource arrangements, or other forms of organized public or collective action. Its distinctive methodological feature is that the intervention can alter incentives, authority, rights, expectations, institutional routines, and strategic response while simultaneously being evaluated. The policy object therefore often changes the field more deeply than a narrow technical treatment.

Definition 11.353 (Policy experimental architecture). A *policy experimental architecture* is a bounded and revisable arrangement in which a policy rule, programme, eligibility structure, resource arrangement, or implementation pathway is introduced or varied so that practical consequences, mechanisms, implementation conditions, and revision needs can be learned under explicit governance and protection conditions.

Policy experiments should distinguish variation in formal design from variation in implementation. The same formal rule can produce different practical histories when administrative capacity, local interpretation, communication, enforcement, trust, or

complementary services differ. The experimental object should therefore include both the policy specification and its enacted institutional configuration.

Policy experimentation also creates expectations. Temporary eligibility can be experienced as recognition; a pilot service can create reliance; an announced trial can change investment or migration decisions; a temporary rule can become a focal point for institutional bargaining. These consequences can persist after the formal experiment ends. The exit architecture should therefore identify which generated expectations or dependencies require transition, explanation, compensation, replacement, or continued support.

Distributional comparison is also central. Average benefit can coexist with concentrated burden, unequal access, or differential implementation. Experimental design should preserve affected positions and value plurality rather than rely only on an aggregate outcome. Participatory and interpretive methods can be necessary to identify effects that a narrow quantitative indicator misses.

A policy experiment can also modify the action space of later decision-makers. It can create administrative capacity, establish a legal category, produce interoperable infrastructure, or demonstrate an alternative that did not previously appear reachable. These generative effects belong to the experimental result even where they were not the primary outcome measure.

11.20.5 Institutional Experiment

Institutional experimentation changes roles, mandates, routines, decision rights, accountability pathways, representation, memory, coordination, or other durable organizational arrangements under bounded and revisable conditions. It is often deeper than a programme pilot because the object of experimentation is part of the architecture through which later interventions are authorized, interpreted, and maintained.

Definition 11.354 (Institutional experiment). An *institutional experiment* is a bounded and governed modification of roles, mandates, routines, authority, accountability, representation, coordination, memory, or other institutional arrangements undertaken so that the practical and generative consequences of the modified institutional configuration can be observed and revised.

The unit of analysis can therefore be an institutional relation rather than an individual subject. Examples include changing who can authorize a decision, adding a review interface, creating a cross-unit coordination role, altering information handoff, or introducing a protected dissent pathway. The relevant outcomes can include response time, error detection, trust, learning, burden distribution, institutional memory, or the generation of new practical options.

Institutional experiments are path-sensitive. Once roles are created, staff trained, records reorganized, or authority redistributed, the pre-experimental institution may no longer be recoverable at low cost. Formal reversibility can therefore overstate practical reversibility. The experiment should preserve a reversibility reserve where possible and record institutional residues that would remain after rollback.

Institutional actors also learn the experimental rule. They can adapt around it, create informal workarounds, strategically route cases, or reinterpret mandates. Such adaptation is not necessarily experimental contamination; it can be part of the generative mechanism. The design should distinguish adaptation that reveals an institu-

tional capability from adaptation that defeats the intended protection or makes the original experiment difficult to interpret.

Because institutional experimentation can alter authority and standing, participation and accountability are especially important. Those affected by a new institutional arrangement can possess knowledge unavailable to the designers and may bear transition costs without holding formal decision rights. The experimental dossier should therefore preserve who was represented, who could contest the design, and who acquired or lost practical power during the experiment.

11.20.6 Intervention-Generated Evidence

Experimental praxis produces evidence from a field that has been changed by the intervention. This fact is epistemically productive but requires discipline. Evidence generated after intervention can reveal how the transformed field behaves; it does not automatically describe the pre-intervention field, an untreated future, or another context. The evidential object should therefore include the intervention history through which the observation became possible.

Definition 11.355 (Intervention-generated evidence). *Intervention-generated evidence* is evidence whose availability, content, distribution, or interpretive significance depends materially on a practical intervention or on the relational, institutional, epistemic, or historical changes produced by that intervention.

Four distinctions are especially useful. An intervention can *reveal* a previously existing relation by making it observable. It can *activate* a latent capacity or mechanism. It can *create* a new relation, category, institution, or capability. It can also *obscure* an earlier condition by changing the observation environment. These processes can coexist, and the resulting evidence should not be assigned to one category without justification.

The evidential provenance should therefore include the intervention version, event order, affected positions, observation regime, implementation adaptations, and relevant field changes. A later analyst should be able to ask whether an observation resulted from the intended mechanism, from the act of observation, from institutional adaptation, from a newly generated capability, or from another contemporaneous transformation.

Experimental evidence can also revise the model family itself. A pilot can reveal that a presumed variable is better represented as a relation, that a fixed subject should be modeled historically, that a transition assumed to be smooth is threshold-dependent, or that a history-space branch omitted at design time is practically important. Such evidence should permit structural model revision rather than be forced into parameter updating of the original model.

Proposition 11.356 (Experimental evidence provenance). *Evidence generated through experimental intervention supports later practical inference only to the extent that the intervention history, observation regime, affected field, inferential target, and relevant changes in representation or mechanism remain sufficiently explicit for the evidential relation to be reconstructed and contested.*

Proposition 11.356 does not require complete reconstruction of the field. It requires enough provenance to prevent evidence from being detached from the intervention conditions that helped produce it.

11.20.7 Performative Observation

Observation inside an experiment can become part of the intervention. Section 11.4 distinguished readout from state transformation while allowing an epistemic event to become performatively coupled to later evolution. Experimental settings make this coupling especially important because measurement, classification, feedback, disclosure, and attention are often built directly into the intervention protocol.

Definition 11.357 (Performative experimental observation). A *performative experimental observation* is an observation, classification, measurement, disclosure, or interpretive event whose production or uptake materially alters the practical configuration, later behavior, institutional process, or accessibility of subsequent histories within the experimental field.

The typed distinction can be preserved schematically. Let an observation map produce a representation,

$$\pi^{(c)} : \Omega \longrightarrow X^{(c)}. \quad (11.46)$$

Equation 11.46 is a readout. If the resulting representation is recognized and institutionally coupled to a transformation, the later state change is represented separately through

$$\Phi_e : \Omega \rightharpoonup \Omega. \quad (11.47)$$

Equation 11.47 represents transformation, not observation itself. The distinction allows an experiment to ask both what was observed and what changed because the observation became actionable.

Performative effects can arise through several pathways. Public measurement can redirect attention. Classification can change eligibility or identity. Feedback can alter behavior. Monitoring can generate strategic reporting. Disclosure can change expectations. Repeated observation can burden participants and change participation. These effects can be undesirable, beneficial, or constitutive of the intervention mechanism itself.

A performativity record should therefore specify the observation event, representation produced, uptake pathway, transformation generated, affected positions, and whether the resulting field remains comparable with earlier observations. Where observation materially changes the experimental system, later measurements should not be interpreted as repeated samples from an unchanged process without further argument.

11.20.8 Reversible Experimentation

Reversibility can make experimentation more informative and ethically defensible, but experimental reversibility should be treated as a practical architecture rather than a label. An intervention can be technically reversible while leaving institutional, relational, epistemic, or historical residues that cannot be undone. The design should therefore distinguish rollback of the focal intervention from restoration of the earlier field.

Definition 11.358 (Reversible experimental architecture). A *reversible experimental*

architecture is an experimental design that preserves specified authority, capability, resources, interfaces, records, alternatives, repair pathways, and transition arrangements so that the focal intervention can be reduced, suspended, withdrawn, replaced, or rolled back under defined conditions while residual consequences remain explicitly tracked.

Reversible experimentation requires a *reversibility reserve*. This can include fall-back infrastructure, financial or material reserves, maintained expertise, preserved access routes, authority to suspend implementation, parallel systems, data needed for restoration, or institutional memory. The reserve should remain available throughout the experiment rather than be consumed by early implementation.

Rollback should also have event-order prerequisites. Replacement capacity can need to exist before withdrawal. Participants can require transition notice before a service ends. Records can need transfer before an institution is dissolved. If those predecessor events are absent, formal authority to stop does not amount to practical reversibility.

The experiment should identify *irreversible residues*. These can include disclosure of private information, changed expectations, learned behavior, environmental transformation, altered institutional legitimacy, path-dependent investments, or created categories. A reversible experiment can therefore remain justified while acknowledging that full restoration is impossible. The relevant question is whether the remaining residues are understood, acceptable, repairable where necessary, and proportionate to the learning and practical objective.

Reversible experimentation also has epistemic value. It permits stronger practical contact while preserving a pathway for correction when model assumptions fail. Yet this benefit should not encourage unnecessary experimentation on affected subjects. Reversibility reduces some risks; it does not erase burdens, power asymmetries, or duties of justification.

11.20.9 Ethical Limits

Experimental methodology is constrained by the fact that the objects of application-dominant praxis can be subjects and institutions whose welfare, rights, standing, relations, and future options are affected by the experiment. Methodological informativeness does not by itself justify exposure. Ethical limits should therefore be built into experimental design as constitutive constraints rather than appended after the experiment has been optimized for learning.

Definition 11.359 (Experimental protection architecture). An *experimental protection architecture* is the set of substantive, procedural, relational, and institutional conditions that bound experimental exposure, preserve protected interests and standing, allocate responsibility, enable contestation and remedy, and constrain learning objectives when experimentation can impose burdens or alter future possibilities.

Several dimensions require explicit attention. *Exposure* concerns who can experience harm, burden, deprivation, uncertainty, stigma, surveillance, or opportunity loss. *Standing* concerns whose interests and interpretations count in experimental design. *Authority* concerns who is permitted to impose variation. *Participation* concerns whether affected subjects can shape or contest the experimental architecture. *Distribution* concerns whether learning benefits accrue to one position while experimental burdens fall on another. *Remedy* concerns repair, compensation, review, and

reopening when harm occurs.

The ethics of comparison groups also require context-sensitive judgment. Withholding an intervention can be methodologically informative in some cases while becoming unacceptable when established protection, rights, or urgent needs would be denied. Conversely, universal immediate rollout can make learning difficult and create larger irreversible exposure when the intervention remains uncertain. The appropriate design depends on the existing epistemic state, consequence severity, reversibility, available alternatives, legitimate authority, and distribution of burden. No single comparison architecture is ethically privileged in advance.

Experimental subjects should not be reduced to data-generating units. Participation can change the experiment itself, and participants may possess knowledge required to understand burden, mechanism, or feasibility. Protection should therefore include intelligibility, voice, contestability, privacy where relevant, safe withdrawal where feasible, and clear allocation of responsibility for consequences. Where individual consent is impossible or insufficient for an institutional experiment, other forms of legitimate authorization and protection remain necessary rather than disappearing.

The experiment should also consider future agency. A bounded trial can create lock-in, normalize surveillance, deplete institutional alternatives, or establish categories difficult to reverse. Ethical evaluation should therefore include history-space and action-space effects, not only immediate outcome risk. A pilot that appears low-risk in the present can still be ethically significant if it materially narrows the choices of later actors.

Proposition 11.360 (Experimental proportionality). *Experimental exposure is methodologically and ethically supportable only when the practical and epistemic value of the experiment, the seriousness of the problem, residual uncertainty, reversibility, burden distribution, affected positions, available alternatives, protection architecture, and expected future-option effects jointly support the depth and scale of commitment.*

Proposition 11.360 is intentionally plural rather than scalar. The relevant considerations need not be collapsed into a single benefit–risk score.

11.20.10 Scaling after Experiment

Scaling after an experiment is a new intervention-design problem rather than mechanical replication of a successful pilot. Increasing breadth, duration, institutional depth, authority, or integration can change the mechanism, affected positions, implementation burden, field structure, observation regime, and history space. A pilot result therefore supplies evidence for scaling only through an explicit transfer and transformation argument.

Definition 11.361 (Scale-transition inference). A *scale-transition inference* is a reasoned and revisable inference connecting evidence and mechanism from an experimental configuration to a proposed wider, deeper, longer, or more institutionalized intervention while explicitly representing the conditions expected to remain stable, the conditions expected to change, and the uncertainties generated by the transition itself.

Scaling can occur along several dimensions. *Breadth scaling* increases the num-

ber or range of affected positions. *intensity scaling* increases intervention magnitude or resource commitment. *temporal scaling* lengthens duration. *institutional scaling* embeds the intervention into durable roles or rules. *depth scaling* reaches further into generative structure. *network scaling* propagates through additional relational pathways. These dimensions can produce different histories even when the nominal programme name remains unchanged.

The scaling question should therefore revisit mechanism validity. A mechanism observed in a small pilot may depend on unusually skilled staff, concentrated attention, temporary resources, participant selection, novelty, or a dense coordination relation that will not exist at wider scale. Scaling can also create interference, congestion, strategic adaptation, supply constraints, or institutional standardization absent in the pilot. The experimental mechanism should be decomposed into components expected to survive the scale transition and components requiring new support.

Scale transition can be examined through the coarse-graining and scale-translation architecture of Section 11.17. If a transformation represented at pilot resolution does not have an adequate counterpart at the proposed wider scale, the intervention may require redesign rather than replication. Likewise, the event-order architecture can change: capabilities generated early in the pilot may need to be generated anew in each scaling branch, and institutional authorization can become a predecessor event that did not exist in the smaller trial.

Definition 11.362 (Scaling remainder). A *scaling remainder* is a practically material mechanism, relation, burden, capability, historical condition, epistemic effect, or uncertainty present in the experimental configuration that lacks a justified correspondence in the proposed scaled configuration, or vice versa.

The scaling remainder should remain visible. It can justify staged expansion, additional pilot branches, redesigned monitoring, stronger participation, or refusal to generalize a result beyond its validity region. A successful experiment can therefore rationally support continued local use without supporting universal expansion.

Scaling should also preserve learning. A wider intervention can remain staged, versioned, and reversible rather than becoming a one-time irreversible rollout. The next implementation stage can generate new epistemic events, reveal new affected positions, change history weights, or generate new action spaces. Scaling architecture should consequently include new monitoring, decision gates, revision conditions, and exit pathways appropriate to the transformed field.

Proposition 11.363 (Experimental transfer and scaling). *Evidence from a pilot or experiment supports wider intervention only to the extent that the relevant mechanism, enabling conditions, affected positions, institutional capacities, observation effects, event-order relations, protections, and history-space consequences possess a defensible correspondence to the proposed scaled configuration, with material remainders and new uncertainties preserved explicitly.*

Proposition 11.363 closes the experimental-intervention block by treating experiment as a generator of practical evidence and transformed conditions rather than as a simple prelude to rollout. Once an intervention enters practice, the next methodological task is to observe its evolving histories continuously enough to detect mechanism change, burden distribution, emerging risks, generative effects, and the consequences of observation itself. Section 303 therefore turns to monitoring and observation regimes.

11.21 Monitoring and Observation Regimes

Section 11.20 developed experimental and pilot intervention as bounded practical contact with an evolving field. The present section develops the observation architecture required once intervention, institutional response, and practical learning continue through time. Its role is to specify how application-dominant praxis can remain epistemically connected to the histories it helps generate without treating observation as passive, indicators as self-interpreting, or monitoring as costless. Its objective is to distinguish immediate, relational, generative, early-warning, and distributional indicators; preserve the typed distinction between readout and transformation; trace action-generated and unintended evidence; support revision of data and representation; and make the burdens of observation themselves visible. The discussion proceeds through observation architecture, several classes of indicators, observer and classification effects, action-generated evidence, unintended effects, data and representation updating, and monitoring burden.

Definition 11.364 (Monitoring regime). A *monitoring regime* is a versioned practical arrangement that specifies what is observed, by whom, through which representation and instrumentation, under which event-order or clock-time conditions, with what provenance and uncertainty, how observations are interpreted and communicated, how observation may affect the field, and which forms of review, revision, escalation, de-escalation, or reopening the resulting epistemic events can activate.

Monitoring is therefore broader than repeated measurement. A monitoring regime can contain quantitative indicators, qualitative observation, participant testimony, institutional records, field inspection, relational mapping, model-generated diagnostics, and event-triggered review. The regime should preserve the distinction between the practical configuration, the observations produced from it, and the transformations that can follow when those observations are interpreted or institutionally taken up.

Table 11.21 summarizes the architecture. The dimensions are mutually connected. An indicator can become performative; an unintended effect can require a new indicator; a distributional pattern can reveal an omitted relation; and monitoring burden can itself alter participation, trust, reporting behavior, or implementation capacity. Monitoring adequacy therefore depends on the regime as a whole rather than on the number of variables collected.

11.21.1 Observation Architecture

An observation architecture specifies the typed relation among practical configuration, observation event, representation, interpretation, institutional uptake, and possible later transformation. Its methodological purpose is to prevent the observation record from being treated as if it were identical to the field and to make explicit where performative effects can enter the practical history.

Let Ω denote a model-specific configuration space and $X^{(c)}$ an observation space for channel c . A readout at an observation event e_o can be represented by Equation 11.48.

$$\pi_{e_o}^{(c)} : \Omega \longrightarrow X^{(c)}. \quad (11.48)$$

Equation 11.48 is a representation of readout, not of the later transformation that can occur when the result is interpreted, disclosed, classified, or acted upon. Where

Table 11.21: Methodological dimensions of monitoring and observation regimes.

Dimension	Primary observation object	Characteristic methodological question
Observation architecture	Observer, object, representation, provenance, and trigger structure	Which observations are produced, under which conditions, and how can they enter later praxis?
Immediate indicators	Manifested state and near-term response	Which changes are visible now, and which conclusions remain premature?
Relational indicators	Dependency, authority, trust, flow, coordination, and access	How are consequential relations changing across positions and interfaces?
Generative indicators	Capacity, option structure, rule change, and future-history potential	Which conditions governing later generation are being strengthened, depleted, or transformed?
Early-warning indicators	Precursors, event patterns, thresholds, and structural changes	Which observations justify attention before major consequences fully manifest?
Distributional indicators	Benefits, burdens, exposure, voice, and recovery capacity	How are consequences distributed across affected positions and horizons?
Observer and classification effects	Performative consequences of observation and representation	How does observing, classifying, disclosing, or ranking change the field being observed?
Action-generated evidence	Evidence produced through intervention histories	What was revealed, activated, created, or obscured by action itself?
Unintended effects	Spillovers, emergent subjects, and unplanned histories	Which consequential changes fall outside the original target and expectation structure?
Representation updating	Data schema, categories, models, and provenance	When should the observation system itself be revised, and how can comparability be preserved?
Monitoring burden	Cost, exposure, attention, surveillance, and participation load	Which burdens are generated by observation, for whom, and with what justification?

uptake of the observation generates a practical change, a separate transformation can be represented by Equation 11.49.

$$\Phi_{e_u} : \Omega \rightharpoonup \Omega,$$

(11.49)

where e_u is an uptake event whose occurrence can depend on the observation, its interpretation, and the institutional pathway through which it acquires practical force. The two mappings preserve the distinction between knowing something about a configuration and changing the configuration through the practical consequences of knowing, communicating, or institutionalizing it.

Monitoring time should inherit the event-ordered architecture developed in Section 11.16. A general observation regime can be represented by a partially ordered set of monitoring events rather than by a uniform clock-time sequence. Some observations are periodic, but others become meaningful only after particular predecessor events. A review can be triggered after implementation, after a specified number of relevant transactions, after an institutional handoff, after a warning event, or after an affected position becomes newly visible. Two observations can remain unordered where no practical precedence relation is warranted.

Definition 11.365 (Observation architecture). An *observation architecture* specifies observation objects, channels, observers, instrumentation or interpretive procedures, event-order or clock-time triggers, representation spaces, provenance, uncertainty, access, communication pathways, performative coupling, and the practical responses that observation can activate.

The architecture should also preserve observation absences. Missingness can arise because an event did not occur, because it could not be observed, because the observer lacked access, because the category did not exist, because reporting incentives suppressed disclosure, or because the monitoring regime did not yet know what to look for. These absences have different epistemic meanings and should not be compressed into a single missing-data category.

Observation architecture should therefore be designed together with intervention architecture. The relevant question is not only whether a variable can be measured, but whether the regime can detect the histories, relations, burdens, capability changes, and rule transformations that matter for later revision. Monitoring that is easy to automate can still be practically inadequate if it systematically observes only the most legible layer of the field.

11.21.2 Immediate Indicators

Immediate indicators record manifested conditions close to an observation event or intervention stage. They can concern current state, uptake, service continuity, operational performance, safety events, near-term exposure, resource use, or another consequence that becomes observable with relatively little historical delay. Their methodological role is often stabilization and rapid feedback rather than explanation of deeper mechanism.

Definition 11.366 (Immediate indicator). An *immediate indicator* is an observation object designed to represent a present or near-term manifested condition whose practical relevance can be assessed with limited temporal or generative reconstruction.

Immediate indicators are especially useful when a practical history contains urgent protection requirements or when a staged intervention needs rapid information before proceeding to a deeper commitment. Their interpretive limitation is equally important: short-latency visibility does not establish causal or generative sufficiency. An intervention can improve an immediate output while degrading a slower institutional capacity, relational condition, or future action space. Conversely, a temporary

deterioration can accompany beneficial reorganization where transition costs occur before later generative gains become observable.

Immediate monitoring should therefore record the relation between the indicator and the intervention stage. A sudden change before the relevant intervention event should not be attributed to that intervention merely because it appears inside the same reporting period. Event-order provenance can be more informative than coarse calendar aggregation when several transformations occur inside one interval.

A useful immediate-indicator record includes the observation event, represented object, expected latency, uncertainty, comparison basis, affected positions, and the practical response that the indicator can legitimately trigger. This protects immediate indicators from acquiring decision authority beyond their evidential scope.

11.21.3 Relational Indicators

Relational indicators observe changing relations rather than only attributes of isolated positions. Their objects can include dependence, authority, trust, information flow, coordination, recognition, care, exchange, access, exit, exposure, or other relations whose configuration shapes later practical possibility.

Definition 11.367 (Relational indicator). A *relational indicator* is an observation object whose primary referent is a relation, interface, or relational configuration among positions rather than an attribute assigned independently to one position.

A relational indicator can be quantitative, qualitative, structural, or mixed. Network measures can represent some forms of centrality, connectivity, or dependence. Process records can reveal authority or coordination. Interviews and local knowledge can reveal informal relations absent from administrative data. The method should therefore select a representation appropriate to the relation rather than assume that every relation has a natural scalar measure.

Relational indicators require semantic discipline. An observed exchange does not automatically establish trust; frequent communication does not establish influence; formal authority does not establish effective control; and identical edge labels in two contexts do not establish equivalent relational meaning. Where a numerical proxy is used, the proxy-to-relation correspondence should remain explicit and revisable.

The direction and asymmetry of relations also matter. A relation that increases one position's access can increase another position's dependency or monitoring exposure. Relational monitoring should therefore preserve position-specific consequences where they are practically material.

Definition 11.368 (Relational monitoring profile). A *relational monitoring profile* records the represented relation, participating positions, direction or reciprocity where relevant, observation method, proxy assumptions, historical context, affected interfaces, uncertainty, and the practical consequences of a materially detected change.

Relational indicators can also become early evidence of deeper structural change. Repeated changes in local coordination, exit dependence, or information flow can indicate that an institutional or field-level configuration is being reorganized before aggregate outcomes visibly change.

11.21.4 Generative Indicators

Generative indicators are designed to observe changes in the conditions that shape later production of actions, capacities, relations, institutions, and histories. Their methodological object is therefore broader than current output. They ask whether praxis is altering what subjects and institutions will later be able to generate, sustain, revise, or recover from.

Definition 11.369 (Generative indicator). A *generative indicator* is an observation object intended to represent a condition that materially affects the later generation, preservation, transformation, or foreclosure of capabilities, relations, institutions, action possibilities, epistemic access, or admissible histories.

Examples can include maintenance capacity, institutional memory, training and skill regeneration, trust repair, redundancy, preserved exit capacity, option generation, observation quality, responsiveness to dissent, or the creation of new coordination pathways. The exact object depends on the generative claim being monitored. A generative indicator should therefore be connected to an explicit mechanism or relational hypothesis rather than selected merely because it appears future-oriented.

Generative monitoring should distinguish present state from future potential. A reserve can remain unused while materially increasing recoverability. A new institutional interface can have little immediate throughput while increasing future coordination capacity. Conversely, a system can maintain present output while consuming the capacities that make later output possible. Monitoring architecture should make these slow or latent conditions visible where they matter.

Where a model uses evolving action spaces, monitoring can examine whether new actions become reachable, latent actions lose activation pathways, or existing options become increasingly costly or dependent on one controlling position. Where a model uses history weights or transition potentials, a monitoring event can justify revision of the relative support assigned to future histories. These are model-specific representations rather than universal quantities; generative monitoring should remain meaningful even when no such formalism is used.

Proposition 11.370 (Generative monitoring adequacy). *Monitoring of generative consequence is adequate only to the extent that the selected observation objects correspond to an explicit account of how later capabilities, relations, institutions, action spaces, or history structures can be produced, preserved, depleted, or transformed.*

Proposition 11.370 guards against labeling any delayed indicator as generative. The defining feature is its relation to future-generating conditions, not simply its temporal horizon.

11.21.5 Early-Warning Indicators

Early-warning indicators seek observations that become practically informative before a consequential history fully manifests. Their role is to support attention, protective action, deeper inquiry, or revision while options remain available. They can be especially important where consequences are nonlinear, delayed, cascading, or difficult to reverse.

Definition 11.371 (Early-warning indicator). An *early-warning indicator* is an observation object whose change, configuration, or event pattern is treated as a precursor warranting specified practical attention before the corresponding adverse or trans-

formative consequence is fully realized.

Early warning need not take the form of a scalar threshold. A warning can arise from a pattern of events, a change in network structure, the appearance of a previously absent relation, a loss of redundancy, a cluster of local reports, a change in model disagreement, or a shift in institutional responsiveness. Threshold rules remain useful when their semantics and error consequences are justified, but they are one possible warning architecture among several.

The event-ordered framework is useful here. A warning event can be defined partly through its position relative to later consequence events. Some precursors become meaningful because they repeatedly occur in the event past of a harmful transition, even when the elapsed clock duration varies across cases. Other warnings depend on event density, branching, or changes in precedence structure rather than on one time series.

Warning systems should record false positives, false negatives, delayed recognition, and strategic adaptation. Actors can change behavior once a warning rule becomes known. Institutions can also become desensitized when warnings are frequent but weakly connected to actionable response. An early-warning architecture should therefore connect observation to response capacity rather than maximize warning sensitivity independently of practical consequence.

Definition 11.372 (Warning-response pathway). A *warning-response pathway* connects an early-warning observation to the responsible position, interpretation procedure, verification or escalation step, protective or adaptive response, and subsequent review of whether the warning relation remained valid.

Without such a pathway, warning indicators can accumulate informational significance while producing little practical protection.

11.21.6 Distributional Indicators

Distributional indicators observe how consequences are allocated across affected positions rather than reporting only aggregate performance. Their methodological role is to connect monitoring with the power, participation, responsibility, and justice architectures developed in Chapter 10.

Definition 11.373 (Distributional indicator). A *distributional indicator* is an observation object designed to represent how a benefit, burden, exposure, risk, capability, voice opportunity, recovery condition, or future option is distributed across practically relevant positions, relations, or temporal horizons.

Distributional monitoring should not assume that all relevant positions are already represented in the dataset. A newly recognized affected subject can require the indicator architecture itself to change. Likewise, equal nominal access can conceal unequal activation cost, waiting capacity, exposure, or ability to obtain remedy. The unit of observation therefore depends on the justice question rather than on administrative convenience alone.

The same aggregate improvement can coexist with concentrated harm. Distributional indicators should preserve this possibility by retaining position-specific or relation-specific information where feasible. Aggregation can still be useful, but its weighting, grouping, and exclusion rules should remain visible.

Distribution can also be temporal. Present actors can receive benefits while fu-

ture actors inherit maintenance burdens, reduced action spaces, or long-latency risks. Monitoring regimes should therefore link immediate distribution with longer-horizon carryover where the intervention plausibly creates such obligations.

A distributional indicator can itself create classification effects. Once eligibility, disadvantage, risk, or benefit is represented through a category, the category can shape access, institutional attention, identity, and strategic behavior. Distributional monitoring therefore leads directly to the performative questions of the next subsection.

11.21.7 Observer and Classification Effects

Observation can alter the field it seeks to describe. Measurement can redirect attention; disclosure can change expectations; ranking can reorganize incentives; classification can create eligibility or exclusion; and repeated observation can alter trust, participation, or strategic behavior. These effects should be represented as part of monitoring methodology rather than treated only as contamination of otherwise neutral data.

Definition 11.374 (Observer effect in applied monitoring). An *observer effect in applied monitoring* is a practically material change in behavior, relation, institution, representation, or later history generated by the presence, procedure, disclosure, interpretation, or anticipated consequences of observation.

Definition 11.375 (Classification effect). A *classification effect* is a practically material transformation generated when a category or classification is recognized, applied, contested, institutionalized, or anticipated by affected positions.

Observer and classification effects can be harmful, beneficial, or mixed. Visibility can create protection, recognition, or resource access while simultaneously increasing surveillance or strategic exposure. A public indicator can improve accountability while encouraging actors to optimize the indicator rather than the underlying objective. The relevant question is therefore which transformation the observation regime generates and whether that transformation is compatible with the practical purpose of monitoring.

The typed distinction of Equations 11.48 and 11.49 is especially important here. A classification first represented in an observation space can later acquire practical force through an uptake event. The pathway between the two should be traceable where it materially affects rights, resources, standing, burden, or intervention history.

Definition 11.376 (Observation-effect record). An *observation-effect record* documents the observation or classification event, uptake pathway, positions affected, represented transformation, expected and unexpected performative consequences, uncertainty, and any resulting revision to the monitoring regime.

Monitoring systems should therefore monitor themselves where the observation regime is materially performative. This reflexivity is not infinite self-observation; it is a proportionate requirement to inspect the consequences of observation when those consequences can alter the object or legitimacy of the intervention.

11.21.8 Action-Generated Evidence

Once action occurs, the resulting practical history generates evidence that could not have been observed in the same form before intervention. Implementation reveals

interfaces, institutions adapt, affected subjects respond, and new constraints or capacities can become visible. Monitoring converts selected traces of this changing field into evidence for later practical inference.

Definition 11.377 (Action-generated evidence). *Action-generated evidence* is evidence whose availability, content, or practical meaning depends materially on an intervention, implementation process, or consequential practical event having occurred.

Action-generated evidence should be classified according to whether the intervention primarily *revealed*, *activated*, *created*, or *obscured* the observed condition. A latent dependency can be revealed when a service is interrupted. A dormant capability can be activated by a new coordination arrangement. A category or relation can be created through institutional recognition. A monitoring redesign can obscure comparison with earlier periods even while improving present measurement.

This classification matters for inference. Evidence generated by a new institution cannot automatically be interpreted as evidence that the same institutional relation existed before the intervention. Likewise, behavior observed after public disclosure can reflect adaptation to the observation regime rather than an unchanged underlying tendency.

Action-generated evidence should therefore retain intervention provenance. The record should preserve which intervention events preceded the observation, which representation produced the evidence, which positions were altered by implementation, and which alternative explanations remain live. This allows later sections on feedback and evaluation to distinguish evidence about the original model from evidence about the transformed field.

Proposition 11.378 (Action-generated evidence provenance). *Evidence generated through intervention is practically interpretable only to the extent that the history of intervention, implementation, observation, and performative uptake relevant to the evidence remains reconstructible enough to distinguish revelation, activation, creation, and obscuration.*

Proposition 11.378 gives action-generated evidence a disciplined role without assuming that intervention merely exposes a pre-existing static reality.

11.21.9 Unintended Effects

Unintended effects are consequential changes outside the intervention's expected or explicitly targeted history structure. They can be adverse, beneficial, ambiguous, or initially uninterpretable. Monitoring should therefore preserve the capacity to observe beyond the variables used to define expected success.

Definition 11.379 (Unintended effect). An *unintended effect* is a practically material change generated or mediated by intervention that was absent from, insufficiently represented in, or outside the expected consequence architecture of the operative intervention design.

Unintended effects can arise through spillovers, strategic adaptation, cross-scale propagation, subject transformation, institutional reinterpretation, observation effects, newly generated relations, or interaction with conditions excluded from the original model. Their absence from the design does not imply that they are causally unrelated to the intervention.

Monitoring should distinguish *unexpected* from *unintended*. A consequence can be expected but undesired; another can be intended but fail to occur; a third can be beneficial yet wholly unanticipated. This distinction improves both responsibility analysis and later model revision.

The event-ordered architecture helps reconstruct unintended effects where several pathways overlap. Rather than asking only whether an outcome occurred after intervention in calendar time, the analysis can examine which intervention, institutional, epistemic, and relational events lie in the represented event past of the consequence and which alternative pathways remain plausible.

An unintended effect can also create a new practical subject or affected position. For example, a new institution can generate a category of participants whose interests did not exist in the same form before implementation. Monitoring architecture should therefore permit revision of the affected-subject map rather than requiring every relevant position to have been specified *ex ante*.

Definition 11.380 (Unintended-effect register). An *unintended-effect register* records the observed effect, affected positions, relevant event history, plausible pathways, scale and depth, reversibility, uncertainty, distributional consequence, and the resulting implications for monitoring, intervention design, and practical closure.

The register is not limited to adverse events. Beneficial emergent effects can identify previously unknown generative mechanisms or action possibilities and can justify revision of the intervention's objectives or theory of change.

11.21.10 Data and Representation Updating

Monitoring produces observations inside representations that can themselves become inadequate as the practical field changes. Categories can lose validity, instrumentation can drift, data-generating processes can change after intervention, and newly recognized subjects can make earlier schemas incomplete. Monitoring methodology therefore requires explicit procedures for updating both data structures and practical representations.

Definition 11.381 (Monitoring representation version). A *monitoring representation version* is a documented configuration of categories, variables, observation channels, mappings, inclusion rules, uncertainty conventions, and interpretive assumptions used to construct monitoring evidence during a specified region of the practical history.

Versioning matters because a series can appear continuous even when its meaning changes. A revised eligibility category, sensor, survey wording, institutional classification, or affected-subject boundary can create a discontinuity in what is being observed. Treating the old and new representations as automatically comparable can create false trends or conceal substantive transformation.

Updating can occur at several levels. *Data updating* adds or corrects observations inside an existing representation. *parameter updating* changes model estimates. *schema updating* changes variables, categories, or relational objects. *boundary updating* changes who or what is represented. *structural updating* changes the model or generative relation used to interpret observations. *history-space updating* changes which future branches are represented as admissible or materially relevant.

Definition 11.382 (Representation bridge). A *representation bridge* is a documented

mapping, correspondence, or qualified non-equivalence between two monitoring representation versions used to preserve whatever longitudinal comparison remains justified after the observation architecture changes.

A representation bridge can be exact, approximate, partial, or absent. Where important objects cannot be translated responsibly, the discontinuity should remain visible rather than being repaired through an arbitrary conversion. Raw provenance, original categories, and earlier model versions should be retained where possible so later re-epistemization can reconstruct what was known and how it was represented at the earlier stage.

Updating should also preserve disagreement. A new representation can improve fit for one purpose while reducing visibility for another. Alternative representations can therefore coexist for a period rather than being forced immediately into one schema. Model plurality and interpretive plurality remain relevant inside monitoring just as they do in diagnosis and decision analysis.

Proposition 11.383 (Monitoring representation revision). *A monitoring representation should be revised when materially relevant epistemic events, practical transformations, affected positions, observation effects, or validity failures make the existing representation inadequate for the decisions and responsibilities it is meant to support, with comparability preserved only to the extent that a justified representation bridge exists.*

Proposition 11.383 prevents longitudinal continuity from becoming a reason to preserve an obsolete observation regime.

11.21.11 Monitoring Burden

Monitoring consumes resources and can redistribute burden. Data collection requires time, attention, infrastructure, expertise, disclosure, participation, and institutional capacity. Observation can expose subjects to surveillance, classification, administrative work, repeated consultation, or strategic risk. Monitoring design should therefore evaluate its own practical cost and relational consequences.

Definition 11.384 (Monitoring burden). *A monitoring burden is a practically material cost, exposure, obligation, attention demand, privacy loss, classification effect, participation load, resource use, or relational consequence generated by the production, maintenance, interpretation, communication, or institutional use of monitoring evidence.*

Monitoring burdens are distributed unevenly. Front-line actors can bear documentation work while central institutions receive analytical benefit. Affected subjects can repeatedly provide testimony without gaining corresponding influence. Data-intensive systems can centralize interpretive authority among actors with technical access. Automated monitoring can reduce some administrative burdens while increasing surveillance or dependence on proprietary infrastructure.

The marginal value of additional monitoring should therefore be considered together with its marginal burden. More observation is not automatically better. A dense monitoring system can consume the very capacity required for implementation, maintenance, care, or adaptation. It can also produce indicator fixation, where organizational attention shifts toward what is measured because it is measured.

Monitoring burden can alter the evidence being collected. Participants can withdraw, simplify reporting, strategically respond, or change behavior under persistent

observation. Burden is therefore not merely an ethical externality; it can become part of the data-generating process and weaken epistemic quality.

Definition 11.385 (Monitoring proportionality). *Monitoring proportionality* is the requirement that the depth, frequency, granularity, intrusiveness, and resource intensity of observation remain proportionate to the practical decisions, uncertainties, risks, responsibilities, and revision capacities the monitoring regime is intended to support.

Proportionality can justify selective rather than exhaustive observation, rotating samples, event-triggered review, local data stewardship, privacy-preserving aggregation, participatory monitoring, or deliberate non-collection where observation would create disproportionate harm. The appropriate architecture depends on the practical field and cannot be inferred from data availability alone.

Monitoring should also have its own exit and revision conditions. Indicators can become obsolete, burdens can accumulate, and a once-useful observation regime can become institutionalized beyond its original justification. Periodic or event-triggered review should therefore ask whether the regime still observes the right objects, whether its categories remain valid, whether its performative effects remain acceptable, and whether some monitoring practices should be narrowed, redesigned, or retired.

Proposition 11.386 (Monitoring-regime adequacy). *A monitoring regime is adequate insofar as it produces decision-relevant and revisable observations of manifested, relational, generative, early-warning, and distributional consequences; preserves provenance and representation change; detects materially relevant unintended histories; represents the performative effects of observation itself; and maintains monitoring burdens proportionate to the practical responsibilities the regime is meant to support.*

Proposition 11.386 closes the observation block by treating monitoring as a reflexive practical architecture rather than a passive stream of measurements. Once observations begin to accumulate, the next methodological task is to determine how they alter models, history weights, intervention pathways, escalation or de-escalation conditions, and the action space itself. Section 304 therefore turns to feedback, reweighting, and adaptive revision.

11.22 Feedback, Reweighting, and Adaptive Revision

Section 11.21 developed monitoring as a reflexive observation regime embedded in an evolving practical field. The present section develops the methodological architecture through which monitored traces, action-generated evidence, warnings, and participant or institutional responses can alter subsequent praxis. Its role is to connect observation with revision while preserving the distinctions among feedback collection, interpretation, epistemic change, model updating, field transformation, strategy revision, action-space regeneration, resequencing, reversal, and exit. Its objective is to make adaptive revision responsive without making it mechanically reactive. The discussion proceeds from feedback collection and interpretation to epistemic events, threshold rules as a special case, model and operator updating, history reweighting, strategy revision, action-space regeneration, adaptive sequencing, and terminal or reversing responses.

Definition 11.387 (Adaptive feedback architecture). *An adaptive feedback architecture* is a versioned practical arrangement that connects observations and consequen-

Table 11.22: Methodological dimensions of feedback, reweighting, and adaptive revision.

Dimension	Primary methodological object	Characteristic question
Feedback collection	Traces, reports, warnings, responses, and provenance	Which consequential signals enter the revision process, from which positions, and under which event conditions?
Feedback interpretation	Meaning, relevance, disagreement, and alternative explanations	What does the feedback support, and which interpretations remain unresolved?
Epistemic events and state change	Typed relation among readout, recognition, uptake, and transformation	Does the feedback revise knowledge, transform the field, or participate in both through distinct stages?
Threshold-based revision	Local trigger rule with explicit semantics and error costs	When is a threshold rule appropriate, and what does it omit from the wider revision architecture?
Model and operator updating	Parameters, structure, operator families, and validity regions	Which representation or transformation rule should change after the epistemic event?
History weights and transition kernels	Relative support, accessibility, propensity, or probability of histories	Which histories are reweighted, generated, or removed, and with what semantics?
Strategy updating	Objective, target, mechanism, scale, depth, timing, and safeguards	Which parts of the intervention strategy should change while preserving a traceable practical identity?
Action-space regeneration	Available, latent, generated, and foreclosed actions	Does feedback merely compare existing actions or change what can be done next?
Adaptive sequencing	Event order, precedence, stages, and branch structure	Which planned event relations should be added, removed, or reordered?
Reversal and exit	Rollback, repair, withdrawal, transfer, and residual obligations	When should adaptive revision give way to reversing or leaving the practical arrangement?

tial traces to interpretation, epistemic updating, model or representation revision, strategy and sequencing changes, action-space revision, and where warranted reversal or exit, while preserving provenance, authority, uncertainty, affected positions, and the distinction between readout and transformation.

Adaptive feedback is therefore broader than a closed control loop. A practical system can receive an observation without revising anything; revise a model without changing the field; change a strategy without changing the intervention target; or performatively transform the field because an observation, classification, warning, or interpretation acquires institutional force. The architecture should preserve these differences rather than compressing them into one generic notion of response.

Table 11.22 summarizes the architecture. The dimensions can interact recursively. A feedback event can revise a model; the revised model can alter the represented

history space; a newly represented branch can generate a new action; the new action can require resequencing; and the resulting intervention can produce further observations. Adaptive revision is therefore best represented as a governed historical process rather than a single update step.

11.22.1 Feedback Collection

Feedback collection begins when practical traces are selected for possible use in later revision. These traces can include monitoring indicators, participant testimony, implementation records, warnings, model residuals, institutional responses, maintenance histories, complaints, failures, beneficial surprises, and changes in the action space. The methodological object is therefore wider than data collection in a narrow statistical sense.

Definition 11.388 (Practical feedback object). A *practical feedback object* is a trace, observation, report, response, event pattern, model discrepancy, or consequence selected as potentially relevant to the continuation, interpretation, revision, reversal, or termination of an intervention or decision pathway.

Feedback objects inherit the provenance requirements of Section 11.21. A useful record identifies the source position, observation or reporting procedure, relevant event history, representation version, uncertainty, access conditions, and any known performative effect associated with producing the feedback. A numerical indicator without these relations can be precise while remaining practically ambiguous.

Collection should also preserve feedback that does not fit the current model. Reports that appear anomalous, qualitative changes that lack an existing category, disagreement among affected subjects, or newly visible consequences can be especially important because they may indicate that the observation architecture or model boundary itself requires revision. Filtering feedback only through established variables can systematically exclude evidence of structural novelty.

The event-ordered temporal architecture developed in Section 11.16 is useful here. Feedback need not arrive on a uniform clock schedule. Some feedback objects become meaningful only after specified predecessor events; some are generated by newly opened branches; others arise concurrently from different positions and remain only partially ordered. A feedback collection plan should therefore record both clock-time labels where operationally necessary and the practical event relations that determine why an observation becomes relevant.

Definition 11.389 (Feedback provenance record). A *feedback provenance record* documents the feedback object, source position, generating event history, observation or reporting process, representation version, uncertainty, access conditions, relevant performative effects, and the practical question for which the feedback is being considered.

Feedback collection is selective by necessity. The appropriate objective is not exhaustive capture but sufficient visibility of the practical objects that can materially alter responsibility, safety, model adequacy, affected positions, intervention logic, or future option structures.

11.22.2 Interpretation of Feedback

Feedback does not determine its own practical meaning. A change in an indicator can represent intervention effect, contextual change, adaptation, measurement drift, reporting behavior, model misspecification, delayed consequence, or a combination of these. Interpretation connects the observed trace to one or more hypotheses about what has changed and why.

Definition 11.390 (Feedback interpretation profile). *A feedback interpretation profile records the practical feedback object, candidate meanings or mechanisms, supporting and conflicting evidence, relevant model assumptions, affected positions, uncertainty, alternative interpretations, and the practical implications that would follow if each interpretation were provisionally accepted.*

Interpretation should preserve the distinction among description, attribution, and practical implication. Observing that a relational indicator changed does not by itself establish which intervention mechanism generated the change. Establishing a plausible mechanism does not by itself determine whether the practical response should be continuation, redesign, deeper inquiry, protection, de-escalation, or exit. These inferential steps can require different evidence and different forms of judgment.

Multiple interpretations can remain live. Rather than forcing immediate convergence, the method can maintain an *interpretive feedback remainder*: materially relevant disagreements, anomalies, or unexplained traces that have not yet been responsibly absorbed into the dominant account. Such remainders can later become especially informative if subsequent events differentiate the competing explanations.

Interpretation can itself become performative. A public explanation of failure, a new institutional classification, or an official interpretation of a warning can change expectations, responsibility, legitimacy, reporting behavior, or resource allocation. The interpretation record should therefore distinguish the content of an interpretation from the practical consequences generated when that interpretation is recognized or institutionalized.

Proposition 11.391 (Feedback interpretation discipline). *Feedback should alter practical commitments only through an interpretation whose evidential basis, alternatives, uncertainty, affected positions, and practical implications are sufficiently explicit for later contestation and revision, with performative consequences of the interpretation recorded where they are materially relevant.*

Proposition 11.391 prevents responsiveness from collapsing into immediate reaction to whatever signal is most visible or institutionally salient.

11.22.3 Epistemic Events and State Change

Once feedback is interpreted, it can become an epistemic event in the sense developed in Section 11.4: a historically situated event that changes a practically relevant representation, claim, model, category, recognized position, or other condition of knowing. Some epistemic events remain within the epistemic architecture. Others become performatively coupled to changes in the practical field.

The typed distinction developed in Section 11.21 remains essential. Observation is a readout into a representation space; recognition or interpretation can revise the epistemic state; institutional uptake can then activate a separate transformation of the practical configuration. These stages can be related by event precedence without

being identified with one another.

A schematic event-order relation among feedback, interpretation, and uptake is stated in Equation 11.50.

$$e_f \preceq e_i \preceq e_u, \quad (11.50)$$

where e_f denotes a feedback-producing event, e_i an interpretive or epistemic event, and e_u a possible uptake event. Equation 11.50 expresses precedence only where the practical history warrants it. The occurrence of e_f does not require either later event, and other events can intervene or remain incomparable in the partial order.

Definition 11.392 (Feedback-mediated epistemic coupling). A *feedback-mediated epistemic coupling* is a traceable relation through which feedback contributes to an epistemic event and that epistemic event, through a distinct practical uptake pathway, alters a configuration, relation, institution, action space, transformation rule, or later history.

This formulation allows feedback to have several different consequences. It may revise only a parameter estimate. It may change the model family used for interpretation. It may generate a new affected-subject category. It may alter an institutional rule. It may change which actions are reachable. It may also have no immediate operational consequence while remaining preserved for later re-epistemization.

The distinction matters for responsibility. If a monitoring system produced a warning but no authorized position could interpret or act on it, the failure lies in a different part of the practical architecture than if the warning was interpreted and deliberately ignored. Adaptive revision should therefore preserve the event history connecting observation, interpretation, authorization, and transformation.

11.22.4 Threshold-Based Revision as a Special Case

Threshold rules remain useful when the relevant quantity, semantics, decision consequence, and error structure are sufficiently stable. Examples include safety limits, reserve requirements, operational tolerances, or pre-authorized escalation conditions. Their proper place is as one local revision architecture inside the broader framework.

A schematic threshold-based revision rule is stated in Equation 11.51.

$$\rho(z) = \begin{cases} \rho_0, & g(z) < \tau, \\ \rho_1, & g(z) \geq \tau, \end{cases} \quad (11.51)$$

where z is a represented feedback state, g a specified diagnostic function, τ a justified threshold, and ρ_0, ρ_1 the corresponding practical responses. Equation 11.51 is meaningful only after the semantics of g , the provenance of τ , and the practical consequences of classification around the threshold have been specified.

Definition 11.393 (Threshold revision profile). A *threshold revision profile* records the observation object, diagnostic function, threshold provenance, error consequences, affected positions, response associated with crossing or leaving the threshold region, hysteresis or persistence conditions where relevant, and conditions under which the threshold architecture itself should be revised.

Threshold rules can fail when the relevant change is structural rather than scalar,

when the observation regime is performative, when the model family is unstable, when several values remain incompletely commensurable, or when the action space changes endogenously. They can also create strategic behavior once actors learn the rule. For these reasons, threshold crossing should not be treated as the general form of adaptive decision.

A threshold can nevertheless be embedded productively inside a richer architecture. For example, crossing a warning threshold can activate deeper inquiry rather than automatically trigger intervention; crossing a safety threshold can constrain an action space while leaving the final response to deliberation; or different thresholds can govern escalation and de-escalation to reduce unstable switching. The methodological question is therefore what practical role the threshold performs.

11.22.5 Model and Operator Updating

Feedback can change the representation used to understand the field or the represented transformation rules through which intervention is expected to operate. These updates should be distinguished. A model can change while the practical field remains approximately the same; the field can change while an obsolete model remains institutionally dominant; or an epistemic event can revise both the model and the practical operator family through performative uptake.

A model-and-operator update can be represented schematically by Equation 11.52.

$$(\mathcal{M}', \mathfrak{A}') = \mathcal{U}^{\text{fb}}(\mathcal{M}, \mathfrak{A}; F, e_i, \omega), \quad (11.52)$$

where F denotes the interpreted feedback record, e_i the relevant epistemic event, $\mathcal{M}$ the current model architecture, and $\mathfrak{A}$ a model-specific family of available or represented transformations. Equation 11.52 is intentionally schematic: the update can be statistical, qualitative, structural, operator-algebraic, institutional, or hybrid depending on the model family.

Definition 11.394 (Feedback-driven model revision). *A feedback-driven model revision is a versioned change to parameters, variables, boundaries, structural relations, model family, validity region, or model plurality architecture justified by interpreted feedback and preserved together with the earlier model and the evidence that triggered revision.*

Operator updating is equally plural. An epistemic event may change the parameterization of an existing transformation, remove an operator from the admissible family, generate a new operator, alter composition rules, or change the domain on which an operator can act. In institutional settings, this can correspond to a new permission, prohibition, capability, interface, or procedural rule.

Updating should preserve disagreement where model comparison remains unresolved. Several models can continue in parallel if they support different aspects of the field or if the evidence is insufficient to justify replacement. Adaptive revision therefore inherits the model-plurality discipline of Section 11.12 rather than forcing every feedback event into one canonical representation.

11.22.6 History-Weight and Transition-Kernel Updating

Where the model represents families of future histories, feedback can alter the relative support assigned to those histories. It can also change the transition structure through which later configurations become reachable. These two operations should remain distinct from changing the history space itself.

A general nonnegative reweighting architecture is stated in Equation 11.53.

$$W'(h) = \mathcal{R}^{\text{fb}}[W, F, e_i, \mathcal{M}'](h), \quad h \in \mathcal{H}', \quad (11.53)$$

where W is a model-specific history-weight function and $\mathcal{H}'$ is the currently represented admissible history family. Equation 11.53 does not assign probabilistic semantics automatically. The weight can represent probability, plausibility, accessibility, transition propensity, simulation mass, or another explicitly defined quantity.

When transition kernels have genuine probabilistic semantics, feedback can instead update a conditional kernel. Where those semantics are absent, the same practical role can be represented through a nonnegative transition potential or another model-specific relation. Normalization should follow the semantics of the model rather than being imposed merely because a mathematical object resembles a probability kernel.

Definition 11.395 (Feedback-induced history revision). A *feedback-induced history revision* is a documented change in history weights, transition relations, admissible branches, or the represented history space generated by interpreted feedback, with the semantics of the updated quantities and the reason for the structural change kept explicit.

An epistemic event can therefore produce at least three different history-level responses. It can *reweight* histories already represented; it can *change transition structure* among represented configurations; or it can *transform the history space* by generating or removing branches. The third case is especially important in GR because feedback can reveal new actions, create new institutional pathways, identify previously unrecognized subjects, or make an earlier branch practically impossible.

The same distinction applies to amplitude-like models where they are independently justified. Feedback can modify amplitudes or the set of histories over which amplitudes are defined, but the additional semantics required for complex-valued quantities remain those established in Section 11.12. Adaptive revision does not by itself provide those semantics.

11.22.7 Strategy Updating

Model revision does not automatically imply strategy revision, and strategy revision need not wait for complete model replacement. Strategy updating concerns changes to the organized practical pathway through which an objective is pursued under current knowledge and institutional conditions.

Definition 11.396 (Strategy revision profile). A *strategy revision profile* records which elements of an intervention strategy change after feedback, including where relevant objective, criteria, target, mechanism, timing, scale, depth, enabling conditions, safeguards, monitoring, sequencing, authority, and exit architecture, together with the justification, uncertainty, and consequences for the practical identity of the interven-

tion.

Strategy revision can be narrow or deep. A narrow update can adjust dosage, staffing, communication, or review frequency while preserving the target and mechanism. A deeper update can change the target layer, alter the mechanism, move intervention across scales, reduce depth, modify the objective, or replace the strategy entirely. Deeper revisions generally require stronger reauthorization because they can change which positions are affected and what the intervention substantively is.

Revision should also avoid overreaction to noisy feedback. The appropriate response can be continued observation, replication, triangulation, or a temporary protective measure rather than immediate redesign. Conversely, insisting on stability for the sake of comparability can preserve an intervention after its mechanism or context has materially changed. Strategy governance therefore requires a balance between continuity and responsiveness.

Definition 11.397 (Strategy version). A *strategy version* is a time- and event-indexed record of the intervention's objective, target, mechanism, scale, depth, sequencing, safeguards, monitoring, and authority configuration used to preserve the provenance of adaptive change across the practical history.

Versioning protects evaluation from treating several materially different strategies as one unchanged intervention. It also supports responsibility by preserving which actors authorized which version under which epistemic conditions.

11.22.8 Action-Space Regeneration

Feedback can change the action space as well as the assessment of actions already present within it. Section 11.10 defined action-space regeneration as the generation or restoration of practical possibilities through changes in knowledge, capacity, institutions, relations, or other enabling conditions. The present subsection places that process inside the feedback architecture.

Feedback can *reveal* a latent action that had been omitted from the decision frame. It can *generate* a new action through knowledge, coordination, capability formation, legal authorization, or institutional redesign. It can *restore* an action previously foreclosed by reversible constraints. It can also *foreclose* an action when new evidence reveals unacceptable risk, when resources are consumed, or when the historical field changes irreversibly.

Definition 11.398 (Feedback-to-action-space pathway). A *feedback-to-action-space pathway* documents how interpreted feedback changes the status, reachability, activation conditions, cost, legitimacy, or existence of one or more practical actions, including the epistemic and institutional events through which the change occurs.

This pathway should distinguish discovery from generation. Learning that an action was already possible is different from creating the capacity, institution, relation, or permission that makes the action possible for the first time. The distinction matters for causal attribution and for later evaluation of whether the intervention increased practical agency.

Action-space regeneration can itself be a deliberate response when every currently reachable option is inadequate. Rather than select the least harmful existing action, adaptive praxis can invest in creating another option. This can require capability building, trust repair, negotiation, infrastructure, institutional redesign, or further

inquiry. Feedback therefore can redirect praxis from *choosing among actions* toward *generating conditions for new action*.

11.22.9 Adaptive Sequencing

When feedback changes the represented field, the planned order of intervention events can also require revision. Adaptive sequencing concerns changes to precedence, staging, branch conditions, and coordination relations in the intervention plan while preserving the event-ordered temporal architecture established in Section 11.16.

A sequence plan should be understood as a planned partial order rather than necessarily a total list. Feedback can add a new prerequisite event, remove a previously required event, introduce a new branch, change the order between two dependent actions, or leave formerly ordered events incomparable when the earlier precedence claim is no longer justified.

Definition 11.399 (Adaptive resequencing record). An *adaptive resequencing record* documents the earlier event-order plan, the feedback and epistemic events that triggered revision, added or removed precedence relations, generated or closed branches, altered stage boundaries, operational clock-time implications where relevant, and consequences for authority, evaluation, reversibility, and responsibility.

Resequencing can change the meaning of later stages. A participation process inserted before design can transform the design object itself. A capability-building stage inserted before delegation can change who is capable of exercising delegated authority. A new protective stage can preserve options that would otherwise be foreclosed. These are generative changes in the history rather than administrative adjustments to a timetable.

Adaptive sequencing should also preserve path dependence. Once some events have occurred, the original sequence cannot simply be restored by editing the remaining plan. Earlier commitments, disclosures, classifications, investments, or relational changes become part of the realized history. Resequencing therefore begins from the transformed field actually inherited at the revision event.

11.22.10 Reversal and Exit

Adaptive revision eventually reaches cases in which continuation through modification is less appropriate than reversal, termination, withdrawal, transfer, or exit. These responses should remain distinct from ordinary strategy updating because they change the relation between the intervention and the practical field more fundamentally.

Definition 11.400 (Adaptive reversal condition). An *adaptive reversal condition* is a specified or newly recognized practical condition under which rollback, restoration, repair, termination, or transition away from an implemented intervention becomes more supportable than continued adaptation of the existing pathway.

Reversal can be triggered by severe adverse consequences, failure of an essential assumption, loss of legitimacy, inability to maintain protective conditions, mechanism failure, unacceptable distributional effects, emergence of a substantially safer alternative, or exhaustion of the institutional capacity required for responsible con-

tinuation. The trigger can be threshold-based, pattern-based, deliberative, model-comparative, or event-structural depending on the practical object.

Exit concerns the relation of a subject, institution, or participating position to the practical arrangement. It can involve withdrawal from a program, transfer of responsibility, termination of a role, or release from a dependency. Formal exit remains inadequate where the practical capacity to leave is absent or where departure transfers severe residual burdens to those who remain.

Reversal and exit are therefore historical processes rather than instantaneous switches. They can require predecessor events such as notification, capability transfer, data handoff, infrastructure transition, compensation, repair, or restoration of alternatives. They can also leave irreversible residues: disclosed information, changed expectations, institutional precedent, sunk infrastructure, or transformed subject positions.

Definition 11.401 (Adaptive closure record). *An adaptive closure record documents the feedback history, interpreted reasons, authorization, reversal or exit pathway, residual obligations, irreversible consequences, preserved records, affected positions, and reopening conditions associated with ending or fundamentally reversing an intervention pathway.*

The possibility of reversal and exit should feed back into earlier design. Interventions that preserve rollback capacity, institutional memory, transferability, and alternatives can remain adaptively governable for longer than interventions that consume the very capacities required to leave them.

Proposition 11.402 (Adaptive-revision adequacy). *An adaptive revision architecture is adequate insofar as it preserves the provenance and interpretation of feedback; distinguishes epistemic updating from practical transformation; treats thresholds as local tools rather than universal decision rules; revises models, operators, history weights, strategies, action spaces, and event sequences at the level warranted by the feedback; and maintains credible pathways for reversal, exit, and responsible closure when continued adaptation is insufficient.*

Proposition 11.402 closes the adaptive-feedback block. Monitoring and revision keep an intervention epistemically and practically responsive while it unfolds, but they do not by themselves establish whether the intervention has achieved its intended or emergent effects across manifested, relational, structural, historical, and generative dimensions. Section 305 therefore turns to evaluation methodologies.

11.23 Evaluation Methodologies

Section 11.22 developed feedback and adaptive revision as a versioned process through which observations, interpretations, epistemic events, model updates, history reweighting, action-space changes, and practical responses can alter an intervention while it unfolds. The present section develops the complementary methodology of evaluation. Its role is to reconstruct what an intervention has generated across manifested, relational, historical, structural, institutional, capability, constraint, option-space, and history-space dimensions without reducing practical significance to one endpoint or one metric. Its objective is to distinguish immediate outcome assessment from broader generative evaluation while preserving attribution limits, event-order structure, affected positions, uncertainty, and the possibility that the

Table 11.23: Methodological dimensions of intervention evaluation.

Dimension	Primary evaluative object	Characteristic question
Immediate outcomes	Manifested conditions and near-term outputs	What changed close to the intervention event, and relative to which reference or expectation?
Relational effects	Dependence, authority, trust, information, recognition, and coordination	Which relations were created, weakened, intensified, redistributed, or made more fragile?
Subject/entity change	Historical-relational constitution, capability, standing, and internal organization	How did affected subjects or entities themselves change through the intervention history?
Downstream effects	Propagated consequences across relations, positions, and scales	Which consequences appeared beyond the focal target or immediate recipients?
Delayed effects	Consequences separated from intervention by event chains or clock duration	Which effects emerged only after intervening processes, accumulation, or latency?
Structural effects	Recurrent organization, topology, roles, and institutionalized pathways	Did the intervention alter the structures that reproduce later practical conditions?
Capacity effects	Sensing, interpretation, coordination, implementation, repair, learning, and revision	Which capacities were created, restored, depleted, concentrated, or made dependent?
Constraint effects	Restrictive, protective, constitutive, and substituted constraints	Which constraints changed, for whom, and what new constraints were generated elsewhere?
Option-space effects	Available, latent, generated, restored, and foreclosed actions	How did the intervention change what affected positions can later do, refuse, revise, or recover from?
History-space effects	Branches, admissible histories, transition structures, and weights	Which future histories became more accessible, less accessible, newly possible, or impossible?
Generative effects	Conditions for later valued generation and responsible adaptation	What capacities, relations, institutions, and future possibilities did the intervention enable or erode?
Historical evaluation	As-of warrant, realized consequences, later evidence, and reinterpretation	How should the intervention be evaluated across changing knowledge states without hindsight distortion?

intervention changes the evaluative objects themselves. The discussion proceeds from immediate and relational effects through subject, downstream, delayed, structural, capacity, and constraint effects, then examines option-space, history-space, generative, and historically situated evaluation.

Definition 11.403 (Practical evaluation architecture). A *practical evaluation architecture* is a versioned arrangement for reconstructing and judging intervention-relevant changes across specified objects, positions, histories, scales, and horizons while preserving the intervention history, observation regime, criteria, uncertainty, alternative explanations, affected positions, and revision conditions associated with each evaluative claim.

Evaluation therefore has at least three separable tasks. It reconstructs *what changed*; it evaluates the practical significance of that change relative to specified criteria and affected positions; and, where warranted, it examines how the intervention participated in generating the observed change. These tasks can draw on different evidence and methods. A strong descriptive change does not by itself establish causal attribution, and a plausible causal attribution does not by itself establish that the change was normatively desirable, fairly distributed, sustainable, or generatively beneficial.

Table 11.23 summarizes the evaluative layers. The layers are analytically distinguishable but can be historically coupled. An immediate output can modify a relation; the relational change can alter a subject's capability; the capability change can generate a new action; the new action can open a history branch; and the resulting institutional trajectory can later transform the criteria by which the intervention is evaluated. Evaluation is therefore a reconstruction of an evolving practical history rather than a terminal reading of a fixed outcome variable.

Definition 11.404 (Evaluation claim profile). An *evaluation claim profile* records the evaluative object, relevant intervention and observation events, comparison basis, criteria, affected positions, evidential support, model or interpretive assumptions, alternative explanations, uncertainty, scope, and practical implication associated with an evaluative claim.

The profile is useful because different evaluative claims can have different evidential standing within the same intervention. A near-term output may be measured precisely while a structural or long-horizon generative claim remains provisional. The methodology should preserve this asymmetry rather than allowing the precision of one indicator to lend unwarranted certainty to the entire evaluation.

11.23.1 Immediate Outcomes

Immediate-outcome evaluation concerns changes observed close to the focal intervention events in the relevant practical ordering. The phrase *immediate* is relational before it is chronometric. An outcome can be immediate because it directly follows a specified intervention event in the represented event structure even when the associated clock duration is long; conversely, a rapid numerical change may be only indirectly related to the intervention if several relevant practical processes intervene.

Definition 11.405 (Immediate outcome profile). An *immediate outcome profile* records the near-term manifested conditions or outputs associated with an intervention, the predecessor intervention events, observation regime, comparison basis, affected positions, criterion version, uncertainty, and attribution status.

Immediate-outcome evaluation can use before–after comparison, matched comparison, experimental estimates, interrupted histories, qualitative reconstruction, process evidence, or other locally justified methods. The selection of method depends on the intervention architecture and the available comparison relations. A strong evaluation should state whether the comparison concerns a reference history, a counterfactual model, a contemporaneous comparison group, an earlier stage, or another explicit basis.

Immediate outcomes are especially important for safety, stabilization, implementation verification, and early-stage adaptive decisions. They can determine whether a pilot remains within its protection envelope, whether a staged intervention should continue, or whether an unexpected consequence requires immediate response. Their practical importance does not make them sufficient for broader evaluation.

A recurring error is to treat the first observable success variable as the intervention’s evaluative object. If a program increases measured access, for example, evaluation may still need to examine whether actual use, dependency, trust, maintenance burden, institutional capability, or later option space changed in the intended way. Section 11.21 distinguished immediate indicators from relational and generative indicators for this reason.

Immediate outcomes can also be performative. Publicizing an early success indicator can generate expectations, legitimacy, investment, imitation, or strategic behavior that changes the later intervention field. Evaluation should therefore record whether the outcome remained merely observed or became an epistemic event whose uptake altered subsequent history.

Remark 11.406 (Outcome precision and evaluative scope). High precision in an imme-

diate outcome estimate strengthens claims about the represented outcome under the stated design; it does not by itself strengthen claims about relational, structural, generative, historical, or normative effects that require additional objects and inferential pathways.

11.23.2 Relational Effects

Relational evaluation examines whether intervention changes the relations through which later practical conditions are generated. Relevant relations can include dependence, authority, information flow, trust, recognition, care, coordination, exchange, conflict, representation, accountability, and exit. A relational effect can be substantively important even when the immediate attributes of the participating positions change little.

Definition 11.407 (Relational effect profile). *A relational effect profile records the relation under evaluation, involved positions, pre-intervention and post-intervention relational configurations, relevant event history, direction and intensity of change where meaningful, distributional consequences, uncertainty, and plausible intervention pathway.*

Relational effects should not be inferred solely from convenient proxies. Communication frequency can increase while trust declines; formal participation can increase while influence remains concentrated; resource transfer can increase while dependency deepens. Evaluation therefore benefits from combining observation, participant interpretation, institutional records, network or higher-order representations where appropriate, and explicit reconstruction of how the relation operates.

The effect can also be asymmetric. An intervention can reduce one position's dependence while increasing another's burden of coordination or care. It can increase institutional visibility while reducing safe exit. Relational evaluation should therefore identify the relevant direction of the relation and the positions from which it is experienced.

Some relational effects are constitutive of later intervention performance. Trust, coordination, or recognition generated during a pilot can make scale-up possible; surveillance, resentment, or representational distance can make later implementation fragile. Relational effects are therefore both evaluative outcomes and possible mechanisms in later histories.

Proposition 11.408 (Relational evaluation principle). *Where the represented mechanism of an intervention depends materially on relations among positions, adequate evaluation requires direct or inferential assessment of those relations rather than relying exclusively on attributes of the participating positions or aggregate outputs.*

11.23.3 Subject and Entity Transformation

Interventions can transform the subjects and entities that later participate in the practical field. The relevant subject is the historical-relational object developed throughout this chapter rather than a fixed preference-bearing point. Evaluation should therefore ask whether capability, standing, internal organization, recognized identity, constitutive relations, institutional roles, or practical memory changed through the intervention history.

Definition 11.409 (Subject-transformation evaluation). A *subject-transformation evaluation* reconstructs intervention-relevant changes in the historical-relational constitution of a subject or entity, including changes in capability, standing, internal organization, constitutive relations, event history, institutional position, and future practical agency.

Where useful, the subject can be represented through a partial order of events, a labeled 2-complex, a relational history, a network with internal structure, or another model that preserves the relevant historical organization. The evaluation should not infer ontological identity from the representation. Its purpose is to make explicit which parts of the subject's historical-relational structure are claimed to have changed.

Subject transformation can be enabling. Capability formation, recognition, restored standing, new organizational memory, or collective agency can expand later action spaces. It can also be constraining. Classification, dependency, role fixation, surveillance, or institutionalization can narrow later possibilities or make exit costly.

The evaluator should also distinguish transformation from selection. If an intervention appears to improve the average capability of participating subjects because less-capable participants leave, the observed composition change differs from genuine capability formation. Similar distinctions arise between identity transformation and reclassification, between collective-agency generation and replacement of participants, and between institutional learning and staff turnover.

Subject transformation can alter the meaning of subsequent outcomes. A later choice made by a more capable or differently constituted subject cannot always be evaluated as though it were the choice of the pre-intervention subject under new options. This is one reason longitudinal evaluation should preserve subject-history versions rather than assume a time-invariant unit of analysis.

11.23.4 Downstream Effects

Downstream effects are consequences that propagate beyond the focal target, immediate recipients, or first-order mechanism through relational, institutional, material, informational, or historical pathways. They can occur at the same representational scale or cross several scales.

Definition 11.410 (Downstream consequence pathway). A *downstream consequence pathway* is a documented or model-supported sequence of relational, institutional, material, epistemic, or generative events through which an intervention-relevant change propagates from a focal target toward later affected positions or practical configurations.

Downstream evaluation should preserve the event path rather than merely correlate the initial intervention with a later condition. A pathway can include mediation, amplification, attenuation, substitution, strategic response, institutional adaptation, or interaction with another intervention. The degree of warranted attribution can vary along the path.

A useful evaluation distinguishes at least three cases. A downstream effect can be *mechanistically anticipated* by the intervention design; it can be *plausibly linked but unanticipated*; or it can be *observed downstream while its relation to the intervention remains unresolved*. These statuses should not be collapsed.

Propagation can also redistribute rather than simply add effects. A local burden can be displaced to another organization, community, time horizon, or maintenance system. Apparent local success can therefore coexist with downstream cost transfer. Multiscale evaluation should make these transfers visible where they are material.

The downstream pathway can itself generate new epistemic events. A consequence first observed outside the focal intervention boundary may force boundary revision and reveal that the original target map was too narrow. Evaluation then becomes a source of practical diagnosis for subsequent cycles.

11.23.5 Delayed Effects

Delayed effects are consequences whose practical manifestation occurs only after intervening events, accumulation, adaptation, maintenance failure, institutional succession, or another latency process. Under the event-ordered conception of time developed in Section 11.16, delay is not defined solely by elapsed clock duration.

Definition 11.411 (Evaluative delay relation). An *evaluative delay relation* records the intervention event or event family, the downstream consequence event, the intervening event structure or latency process, optional clock-time labels where relevant, and the uncertainties connecting the earlier intervention to the later manifestation.

Some delayed effects are predictable from known lags; others appear only because the intervention transforms the conditions through which later events unfold. A training intervention, for example, can produce no immediate organizational change until authority is delegated later. Infrastructure can appear successful until deferred maintenance accumulates. A classification can have little immediate effect but later become embedded in institutional routines and eligibility rules.

Continuous-time or discrete-time delay models remain available where appropriate, but they are special representations. In a partial-order history, an effect can be delayed because several generatively necessary events lie between the intervention and consequence even if a single scalar duration is not meaningful.

Delayed evaluation requires preservation of institutional memory. If the original intervention rationale, design version, uncertainty, and affected positions are lost, later consequences can become detached from the historical conditions needed to interpret them. Evaluation therefore depends on the provenance and handoff architectures developed in Chapters 10 and 11.

A long delay also complicates responsibility. Personnel, institutions, rules, and environmental conditions can change between intervention and manifestation. Evaluation should distinguish historical causal participation from current responsibility for monitoring, repair, continuation, or compensation.

11.23.6 Structural Effects

Structural evaluation examines recurrent organization rather than isolated states. Relevant structures can include role configurations, network topology, access pathways, infrastructures, recurring dependencies, standards, higher-order relations, and institutionalized patterns that reproduce practical conditions across events.

Definition 11.412 (Structural effect profile). A *structural effect profile* records intervention-relevant changes in recurrent relational organization, including topol-

ogy, role structure, access pathways, infrastructure, repeated dependencies, persistence, affected positions, and the mechanisms through which the changed structure reproduces later practical conditions.

Structural change should be distinguished from repeated state change. A program can repeatedly transfer resources while leaving the access structure unchanged; another intervention can modify the access rule so that later transfers occur differently without repeated discretionary action. The second case is structurally deeper even if its immediate output appears modest.

Evaluation should also preserve the useful functions carried by the earlier structure. A restructuring can reduce one harmful dependency while unintentionally eliminating redundancy, institutional memory, care relations, or rapid coordination. Section 11.18 emphasized this problem when discussing intervention depth. Structural evaluation therefore examines both removed and regenerated functions.

The persistence of structural effects matters. A formally changed structure can revert through informal adaptation; a temporary workaround can become institutionalized through repeated use. Evaluation should therefore distinguish formal structural change, enacted structural change, and durable structural reproduction.

Where formal models are used, structural effects can be represented through network or higher-order changes, altered operator composition, changed access graphs, or other model-specific structures. Their practical interpretation still requires historical and institutional reconstruction.

11.23.7 Capacity Effects

Capacity evaluation asks what affected positions become able to sense, interpret, decide, coordinate, implement, maintain, repair, learn, contest, or revise after intervention. Capacity is relationally activated and should not be inferred solely from resource possession.

Definition 11.413 (Capacity effect profile). A *capacity effect profile* records the practical capacity under evaluation, relevant resources and activation relations, pre-intervention and post-intervention reachability, distribution across positions, maintenance requirements, dependence on external support, decay or regeneration conditions, and implications for later action.

The profile should distinguish *temporary performance* from *durable capacity*. Extraordinary staffing, emergency funding, consultant support, or unusual political attention can generate high performance during a pilot without creating an institution that can reproduce the capability under ordinary conditions. Conversely, early performance can remain modest while a new training, coordination, or memory architecture gradually creates durable capacity.

Capacity can also become concentrated. An intervention may increase total technical capability while making other positions increasingly dependent on one provider, one model, one infrastructure, or one institutional gatekeeper. Evaluation should therefore examine distribution, redundancy, substitutability, and the ability of affected subjects to exercise the capacity independently or collectively.

Capacity loss is equally important. Automation, centralization, outsourcing, or rule simplification can reduce the need for some local skills until those skills disappear. The immediate intervention can appear efficient while future repair or adaptation

capacity declines. Such effects belong to generative evaluation even if they are not visible in the primary outcome metric.

11.23.8 Constraint Effects

Constraint evaluation examines how intervention changes the restrictions, protections, permissions, dependencies, and constitutive boundaries that shape later practical possibility. The evaluative object includes both the removal of constraints and the creation or redistribution of new ones.

Definition 11.414 (Constraint effect profile). A *constraint effect profile* records the constraint type, affected positions, pre-intervention and post-intervention operation, protective or constitutive function where relevant, modifiability, substitution or displacement, interaction with capacities, and consequences for later practical agency.

A reduction in one constraint can create another. Removing a procedural requirement can reduce delay while increasing exposure to error or weakening contestability. Expanding access to a digital service can reduce spatial barriers while creating data, device, identity, or literacy constraints. Constraint evaluation should therefore look for *constraint substitution* and *constraint transfer* across positions and scales.

Protective and constitutive constraints require special care. Rights, safety limits, reserves, due-process requirements, and ecological boundaries can restrict immediate action while preserving future agency or preventing irreversible harm. Evaluating an intervention as successful because it “removed friction” can therefore be misleading if the removed constraint carried a protection that has not been replaced.

Constraint effects are often coupled with capacity effects. A formal restriction can become less significant when capability increases; a nominal permission can remain unusable when activation capacity is absent. Evaluation should therefore avoid treating constraints and capacities as independent scalar quantities.

11.23.9 Option-Space Effects

Option-space evaluation asks how intervention changes the actions that affected positions can later reach, generate, refuse, revise, sequence, or recover. It builds directly on the evolving action-space framework of Sections 11.7 and 11.22.

Definition 11.415 (Option-space effect profile). An *option-space effect profile* records intervention-relevant changes in available, latent, generated, restored, and foreclosed actions, together with the capacities, constraints, authority, knowledge, relations, costs, and event histories that explain the change in practical reachability.

Option-space evaluation should distinguish *discovery* from *generation*. Recognizing an action that was already reachable differs from creating the capability, legal authorization, institution, relation, or infrastructure that makes an action newly possible. The difference matters for both attribution and evaluation of generative value.

Foreclosure can be harmful or protective. An intervention can eliminate harmful actions through safety rules or rights protections; it can also destroy alternatives, exit routes, local capabilities, or future design branches. Evaluation therefore examines which options were foreclosed, for whom, through whose authority, and with what possibility of later restoration.

Option-space effects are particularly important where immediate outcomes look

similar across interventions. Two interventions can achieve comparable current performance while leaving radically different future possibilities. One can preserve modularity, learning, and exit; another can generate lock-in. A terminal outcome comparison would miss this difference.

A useful evaluative record therefore asks whether the intervention increased future *agency* or merely increased the number of nominal options. Effective options require the capacities and conditions needed for meaningful exercise.

11.23.10 History-Space Effects

History-space evaluation examines how intervention changes the set, structure, or relative support of possible future histories. It is broader than option-space evaluation because a history can differ through institutional evolution, subject transformation, exogenous events, coordination patterns, or generative-rule changes even when the immediately available action set appears unchanged.

Definition 11.416 (History-space effect profile). A *history-space effect profile* records whether an intervention reweights represented histories, alters transition structure, creates or removes branches, changes admissibility, modifies event precedence, transforms generative rules, or changes the representation required to describe later histories.

Where a model supports history weights, an evaluation can compare model-specific pre-intervention and post-intervention weight structures. This does not require probabilistic semantics. The weights can represent accessibility, plausibility, transition propensity, simulation mass, or another explicitly defined quantity. The key evaluative question is whether the intervention changed the relative practical support of later histories and how that claim is warranted.

History-space transformation is stronger than reweighting. A new institution can generate a branch that did not previously exist in the model; a rule change can make an earlier branch inadmissible; a performative epistemic event can change actor expectations and thereby create new coordination histories. In such cases, comparing weights on a fixed history space would misrepresent the intervention.

The event-ordered conception of history is especially useful here. Evaluation can ask whether the intervention added new event types, changed predecessor relations, generated alternative branch points, or made formerly incomparable events dependent. A labeled 2-complex or other partially ordered representation can make these transformations explicit where appropriate.

History-space evaluation should remain model-plural. Different models may disagree about which branches exist or how they should be weighted. Such disagreement belongs in the evaluation rather than being hidden by selecting one model after the fact.

11.23.11 Generative Effects

Generative evaluation asks what the intervention changes about the capacity of the practical field to produce later valued conditions, responsible agency, learning, repair, coordination, and revision. It integrates but does not collapse the preceding evaluative layers.

Definition 11.417 (Generative effect). A *generative effect* is an intervention-relevant change in the conditions through which later capabilities, relations, institutions, knowledge, options, histories, values, or forms of agency can be generated, sustained, regenerated, revised, or foreclosed.

Generative effects are not equivalent to long-term effects. A consequence can occur far in the future without changing the field's generative organization, while a near-term change in trust, institutional memory, classification, or capability can immediately alter many later possibilities. The defining issue is whether the intervention changes the conditions of later generation.

Generative evaluation can therefore examine, among other objects, capability formation, institutional self-revision, relational regeneration, maintenance capacity, protected dissent, knowledge production, option creation, repairability, and preservation of future epistemic agency. It can also identify negative generative effects such as lock-in, dependence, concentrated control, loss of local knowledge, erosion of repair capacity, or narrowing of future action spaces.

Definition 11.418 (Generative evaluation profile). A *generative evaluation profile* records the later-generating conditions altered by an intervention, the event and relational pathways through which the alteration occurred, the affected positions, temporal and scale horizons, durability, uncertainty, enabling or constraining effects on future agency, and the relation between the generative effect and the intervention's stated or emergent objectives.

Generative evaluation should preserve heterogeneity. Increasing one kind of generative capacity can reduce another. Centralization can increase rapid coordination while weakening local experimentation. Standardization can improve interoperability while narrowing plural forms of knowledge. Automation can increase processing capacity while eroding human maintenance or interpretive capability. These effects need not be forced into one scalar index.

The methodology should also distinguish *generated value* from the later economics-specific theory of heterogeneous value transmission, conversion, return, capture, and justice developed in the substantive GRE parts. At this stage, generative evaluation provides the general praxis architecture required for those later economic questions.

Proposition 11.419 (Generative evaluation principle). *Evaluation of application-dominant praxis is generatively adequate only when it examines, where materially relevant, how the intervention changes the conditions under which later subjects and institutions can generate, sustain, contest, repair, and revise practical possibilities, rather than evaluating only the manifested endpoint of the original intervention.*

11.23.12 Historical Evaluation

Historical evaluation reconstructs an intervention across changing epistemic, institutional, and relational states. Its central methodological problem is to evaluate realized consequences without rewriting the earlier decision as though later knowledge had already been available.

Definition 11.420 (Historical evaluation dossier). A *historical evaluation dossier* preserves the intervention's as-of practical state, including the evidence, models, uncertainty, criteria, affected positions, action space, authority, dissent, expected histories, and revision conditions available at the relevant decision event, together with the

realized intervention history, later evidence, consequences, reinterpretations, and subsequent revisions.

Historical evaluation therefore contains at least two different questions. The first asks whether the earlier decision or intervention was warranted relative to the information, values, authority, and alternatives reasonably available at that historical position. The second asks what consequences actually followed and what should now be learned, repaired, revised, or reassessed. The answers can differ.

A harmful realized consequence can reveal a serious model failure or an ignored warning; it can also arise from a genuinely unforeseeable event under an earlier decision that was proportionately warranted. Likewise, a favorable outcome does not retroactively establish that the earlier reasoning was sound. *Ex ante* warrant and *ex post* consequence should therefore remain historically distinguishable.

The event-ordered architecture supports this distinction naturally. Each evaluative claim can be indexed to an *as-of event*: the latest epistemic and practical events that were legitimately available to the relevant decision position. Later events belong to the evaluator's historical future relative to that decision and should not be silently imported into its justification.

Definition 11.421 (As-of evaluation state). An *as-of evaluation state* is the reconstructed practical and epistemic configuration associated with a specified historical event, including the information, models, action space, institutional conditions, values, and uncertainty that were available or reasonably accessible at that point.

Historical evaluation also permits re-epistemization. Later concepts, models, archives, testimony, or evidence can produce a richer reconstruction of the intervention and its consequences. This later reconstruction should remain connected to the earlier as-of state so that reinterpretation does not become hindsight substitution.

A further issue is criterion drift. The values or evaluation criteria applied later may differ from those formally used at the original decision. Later evaluation can legitimately criticize earlier criteria, but the evaluation should distinguish *historical reconstruction of the earlier criterion architecture* from *present normative reassessment*. Both can be important; they answer different questions.

Proposition 11.422 (Historical-evaluation adequacy). *Historical evaluation is adequate insofar as it preserves the event-ordered distinction between earlier as-of warrant and later realized consequence; reconstructs changes in evidence, models, criteria, institutions, subjects, and action spaces; permits later re-epistemization without hindsight substitution; and retains enough provenance for practical learning, responsibility, repair, and revision to remain contestable.*

Proposition 11.422 closes the evaluation block. Evaluation can establish that an intervention achieved some objectives, generated valuable capacities, transferred burdens, altered subjects, foreclosed options, or transformed the history space. It can also reveal that the intervention failed to operate as intended, that its mechanism was misidentified, or that repair is now required. Section 306 therefore develops failure detection and repair as a distinct methodological architecture.

11.24 Failure Detection and Repair

Section 11.23 developed evaluation as the reconstruction of intervention histories across immediate, relational, historical, structural, capacity, constraint, option-space, history-space, generative, and later re-epistemized effects. The present section develops the methodology required when that reconstruction indicates that an intervention, implementation process, model, institution, protection architecture, or generative pathway is failing to perform an intended or required practical function. Its role is to distinguish failure detection from retrospective outcome description and to connect failure signals to diagnosis, protection, repair, compensation, institutional learning, and revision. Its objective is to preserve the event-ordered and relational architecture established throughout this chapter while avoiding the inference that every adverse outcome falsifies an intervention theory or that every nominally successful output demonstrates practical adequacy. The discussion proceeds from failure criteria and early signals through failure as an epistemic event, unintended and perverse effects, harm detection, repair and compensation, institutional learning, and revision after failure.

Definition 11.423 (Practical failure). A *practical failure* is a materially relevant divergence between the realized or emerging intervention history and a specified practical function, protection condition, mechanism requirement, criterion, responsibility, or generative condition, under an explicitly stated scope and historical position.

Definition 11.423 makes failure relational and criterion-indexed. An intervention can achieve one objective and fail another. A mechanism can function while implementation fails. A program can satisfy its immediate output criterion while degrading future capability or violating a protected condition. Conversely, an adverse event can occur even where the intervention remains broadly adequate, especially when the event lies outside the warranted control or prediction envelope. Failure analysis therefore requires localization rather than immediate totalization.

Definition 11.424 (Failure localization profile). A *failure localization profile* records the practical layer at which a suspected failure occurs, the relevant criterion or function, the event history through which the divergence became visible, affected positions, alternative explanations, uncertainty, propagation pathways, and the response options available at the time of diagnosis.

Table 11.24 summarizes the section's diagnostic architecture. The layers can overlap. A representation failure can produce implementation error; institutional fragmentation can suppress an early warning; a mechanism failure can become a generative failure after repeated commitment; and a failure to learn can reproduce an earlier harm in a later institutional generation. Failure analysis therefore follows the historical path of divergence rather than assigning one label solely from the final outcome.

11.24.1 Failure Criteria

Failure detection begins with a criterion architecture. The relevant criterion can concern objective attainment, safety, justice, institutional legitimacy, mechanism operation, implementation fidelity, capability preservation, reversibility, maintenance, participation, or another protected practical condition. A failure criterion should therefore state what function is being assessed and why divergence from that func-

Table 11.24: Methodological layers of failure detection and repair.

Layer	Characteristic diagnostic question	Potential response
Criterion failure	Did the intervention cease to satisfy a stated or protected practical condition?	Clarify criterion, protect affected positions, re-assess continuation.
Signal failure	Were warning events absent, ignored, misclassified, or disconnected from response?	Redesign observation and escalation pathways.
Mechanism failure	Did the represented generative pathway fail to operate as expected?	Reconstruct mechanism, revise model or intervention logic.
Implementation failure	Did execution diverge from the intended intervention architecture?	Repair capability, coordination, sequencing, or operational conditions.
Representation failure	Did categories, measurements, models, or boundaries obscure the relevant process?	Re-epistemize the problem and revise the observation/model architecture.
Institutional failure	Did mandate, authority, accountability, memory, or coordination fail to support responsible action?	Repair or redesign institutional relations and responsibility pathways.
Harm realization	Did the intervention generate or amplify materially relevant harm?	Protect, contain, repair, compensate, and re-assess commitment.
Generative failure	Did later capability, reparability, option space, or responsible agency deteriorate?	Restore generative conditions and reconsider intervention depth or rule structure.
Learning failure	Did the institution preserve consequences without changing future praxis?	Convert findings into memory, rules, capability, and review architecture.
Revision failure	Did the intervention remain unchanged after materially relevant evidence or failure?	Escalate revision, reversal, or exit pathways.

tion matters.

Definition 11.425 (Failure criterion). *A failure criterion is a versioned practical condition whose violation, deterioration, or persistent non-attainment provides warranted grounds for diagnosing a specified mode of failure, subject to stated uncertainty, observation conditions, and response implications.*

A failure criterion differs from a success metric. Success criteria often ask whether an intended effect occurred. Failure criteria can also identify unacceptable side effects, loss of protective conditions, disappearance of repair capacity, institutional breakdown, or destruction of future options. An intervention can therefore cross a failure criterion even while its headline output continues to improve.

Failure criteria can be threshold-based where the practical object warrants a threshold. They can also be relational, structural, event-pattern, or qualitative. A protective criterion may be violated by the appearance of an unauthorized relation; a mechanism criterion may fail when a required predecessor event does not occur; a generative criterion may fail when capability or option-space contraction persists despite acceptable current output. The criterion architecture developed in Section 11.3 therefore remains broader than scalar cutoffs.

Definition 11.426 (Failure-criterion profile). *A failure-criterion profile records the criterion, practical object, protected or intended function, affected positions, observation method, uncertainty, temporal or event-order scope, severity, required response, authority for interpretation, and conditions for criterion revision.*

Failure criteria should be established before avoidable harm where possible, yet they remain revisable. New epistemic events can reveal that an earlier criterion was insensitive to a relevant relation, subject, time horizon, or history-space effect. Revision should preserve the earlier criterion version so that historical evaluation can reconstruct what the institution was actually capable of detecting at each stage.

Proposition 11.427 (Failure-criterion adequacy). *A failure criterion is practically adequate insofar as it identifies a materially relevant function or protection condition, connects that object to an observation and response pathway, preserves uncertainty and*

affected positions, and remains revisable without erasing earlier versions or shifting the criterion solely to protect the intervention from adverse evaluation.

11.24.2 Early Failure Signals

Early failure signals are observations or event patterns that provide reason to investigate emerging failure before the full consequence structure is realized. Their value lies in preserving time, reversibility, repair capacity, and future options. They are therefore closely related to the early-warning architecture of Section 11.21, while failure detection gives them a more specific diagnostic and response role.

Definition 11.428 (Early failure signal). An *early failure signal* is an observed event, relation, pattern, divergence, or structural change that materially increases the practical relevance of a specified failure hypothesis before failure is fully manifested or conclusively attributed.

The definition is intentionally weaker than a failure conclusion. A signal should trigger attention, checking, protection, or diagnostic escalation appropriate to its severity; it does not automatically establish the cause. Repeated local complaints, declining maintenance capacity, increasing implementation variance, disappearing redundancy, a newly concentrated dependency, or divergence between observation sources can all function as early signals without independently proving a complete failure mechanism.

Signals are especially important in event-ordered histories. A predecessor event can be practically significant even before a terminal adverse outcome occurs. If a protective review event fails to occur before an irreversible commitment, the missing event itself can be an early failure signal. Likewise, a branch in the realized intervention history can disclose that the intervention has entered a region where earlier protection assumptions no longer apply.

Definition 11.429 (Failure-signal pathway). A *failure-signal pathway* records the signal event or pattern, observation source, interpretation, responsible review position, protective or diagnostic response, escalation conditions, and the later outcome of the signal assessment.

Signal systems can themselves fail. Warnings may be unobserved, inaccessible, suppressed, normalized, or disconnected from authority. A technically accurate monitoring system therefore provides little protection if those who receive a signal lack standing or capacity to alter the intervention. Failure detection should evaluate the complete signal-to-response pathway rather than the existence of indicators alone.

Early signals can also create false alarms. The appropriate response depends on the cost of checking, the potential severity and reversibility of the suspected failure, the quality of the signal, and the possibility that the observation process itself is performative. The methodology therefore favors proportionate escalation over automatic intervention.

11.24.3 Failure as Epistemic Event

Recognition of failure can itself become an epistemic event. A realized divergence can expose a missing mechanism, omitted subject, incorrect boundary, false assumption, inadequate model, neglected institutional relation, or unforeseen generative conse-

quence. Failure can therefore change what is known about the intervention and, through institutional uptake, can also change the field in which later action occurs.

Definition 11.430 (Failure epistemic event). A *failure epistemic event* is a failure-relevant event whose recognition materially changes a practical representation, model, uncertainty structure, criterion, subject map, action space, history-space representation, or other epistemic condition relevant to subsequent praxis.

The typed distinction developed in Section 11.4 remains important. A failure event can first be observed through a readout, testimony, record, evaluation, or model discrepancy. Recognition and interpretation can then revise the epistemic architecture. A later organizational or practical response can transform authority, resource allocation, monitoring, intervention sequencing, or the field itself. These events can be causally and institutionally connected while remaining analytically distinct.

Failure can generate evidence without uniquely identifying its cause. A realized adverse outcome can be compatible with a mistaken mechanism, implementation breakdown, contextual change, strategic response, measurement failure, or interaction among several factors. The methodology should therefore treat failure as an opening for discriminating inquiry rather than as automatic falsification of the highest-level theory associated with the intervention.

Definition 11.431 (Failure decomposition). A *failure decomposition* is a structured reconstruction that distinguishes, where relevant, failures of problem formulation, evidence, model, mechanism, target selection, timing, scale, depth, implementation, coordination, institution, observation, evaluation, maintenance, or generative consequence, together with their possible interactions and unresolved attribution.

Failure decomposition also protects against the opposite error: explaining away every adverse result as implementation noise. If repeated failures occur across competent implementations, the mechanism, target, model, criterion, or institutional architecture may require deeper revision. The evidential pattern across failures can itself become a higher-order epistemic event.

Remark 11.432 (Failure and theory revision). A failure can justify parameter revision, model revision, theory revision, intervention redesign, institutional repair, or a return toward research-dominant praxis. The warranted depth of revision depends on where the failure is localized and how strongly alternative explanations remain supported.

11.24.4 Unintended Consequences

Unintended consequences are effects that were not part of the intervention's operative intention or design expectation. They can be beneficial, harmful, mixed, or initially indeterminate. Their methodological importance lies in revealing the limits of the original intervention model and the broader generative field in which the intervention operates.

Definition 11.433 (Unintended consequence profile). An *unintended consequence profile* records the consequence, affected positions, relation to the intervention history, whether the consequence was anticipated in any model or scenario, plausible generative pathways, severity, reversibility, uncertainty, distribution, and implications for monitoring, repair, revision, or future design.

An unintended consequence should be distinguished from an unexpected conse-

quence. A consequence can be anticipated as possible yet remain unintended. Conversely, a beneficial emergent effect may be unexpected but compatible with the intervention's broader orientation. The distinction helps evaluation preserve both design intention and actual historical generation.

Unintended consequences can expose omitted relations or scales. A local intervention may transfer administrative burden to another organization; a protective classification may stigmatize a subject; a new monitoring system may improve visibility while changing trust; an efficiency reform may reduce slack needed for repair. These effects can occur without failure of the focal mechanism. They still belong to the intervention's practical consequence structure.

Unintended effects can also generate new options. An unplanned coordination relation, learned capability, or institutional routine can create a useful branch that the original intervention did not represent. Repair-oriented methodology should therefore avoid assuming that every departure from design is an error to be removed.

Proposition 11.434 (Unintended-consequence discipline). *Unintended consequences should be incorporated into intervention evaluation and revision according to their actual relational and historical significance, rather than being classified as failure merely because they were absent from the original design or excluded from consideration merely because the intended mechanism succeeded.*

11.24.5 Perverse Effects

A perverse effect is a more specific form of unintended consequence in which an intervention contributes to conditions opposed to one of its own important objectives, protections, or generative requirements. The term should be used carefully because an effect can appear adverse under one criterion while remaining beneficial under another.

Definition 11.435 (Perverse effect). *A perverse effect is an intervention-relevant consequence through which the intervention's mechanism, implementation, representation, institutional uptake, or adaptive response contributes materially to deterioration in a practical condition that the intervention was intended or required to protect, improve, or sustain.*

Perverse effects often emerge through feedback. A metric introduced to improve performance can redirect effort toward the metric while degrading the underlying practice. A protective procedure can become so burdensome that affected subjects lose access. A centralization intended to improve coordination can weaken local sensing and produce slower detection of failure. Such effects can be relational and generative even when immediate output measures remain favorable.

The mechanism of reversal matters. Some perverse effects arise because actors adapt strategically to a rule. Others arise through crowding out, path dependence, classification effects, resource displacement, loss of redundancy, or institutional overload. The response should therefore target the generating relation rather than merely correcting the final indicator.

Definition 11.436 (Perverse-effect pathway). *A perverse-effect pathway reconstructs the event and relational sequence through which an intervention-relevant process contributes to deterioration in a protected or intended practical condition, including mediators, adaptive responses, affected positions, uncertainty, and possible repair*

points.

A perverse effect can also transform later histories by creating distrust, defensive behavior, exit, workaround institutions, or new dependencies. Detecting such history-space effects early can preserve more repair options than waiting for the final objective to deteriorate visibly.

11.24.6 Harm Detection

Harm detection concerns consequences serious enough to require protective attention regardless of whether the intervention has yet been judged a failure in a broader sense. The methodological priority is to identify affected positions, severity, propagation, reversibility, and immediate protection needs while preserving uncertainty about final attribution where necessary.

Definition 11.437 (Harm detection profile). A *harm detection profile* records the manifested or credibly emerging harm, affected positions, observation and testimony sources, event history, severity, reversibility, propagation risk, alternative explanations, intervention-relevance, immediate protective needs, and responsible response positions.

Harm can be material, relational, institutional, epistemic, procedural, capability-related, or generative. Loss of standing, concentrated dependence, destruction of repair capacity, silencing of local knowledge, or irreversible option foreclosure can be materially important even when they are poorly represented by immediate output metrics.

The protection response can precede complete causal attribution. If a severe and reversible exposure can be reduced while investigation continues, the practical architecture can justify protective action without claiming that the causal question has already been settled. Such action should preserve provenance and remain proportionate to uncertainty, urgency, and the consequences of both protection and non-protection.

Definition 11.438 (Protective response envelope). A *protective response envelope* specifies the temporary protective actions permitted after a harm signal, their scope, authority, affected positions, reversibility, monitoring, evidential purpose, review event, and conditions for continuation, modification, or withdrawal.

Harm detection should also examine reporting asymmetry. Positions with limited institutional access, time, safety, language, technical standing, or credibility can experience harm earlier than central monitoring systems register it. Participatory and local-knowledge interfaces therefore remain part of harm detection rather than optional supplements.

A harm report can itself be a high-stakes epistemic event. Its treatment can alter trust, participation, organizational legitimacy, and willingness to report future failures. The process for receiving and responding to harm consequently becomes part of the intervention's generative architecture.

11.24.7 Repair

Repair is the practical attempt to restore, regenerate, or replace conditions damaged by intervention failure or harmful consequences. Repair should be distinguished

from returning an indicator to its earlier value. The relevant object can be a relation, capability, institution, subject position, history-space branch, or condition of future agency that requires reconstruction rather than numerical correction.

Definition 11.439 (Repair target). A *repair target* is the damaged or degraded practical condition whose restoration, regeneration, substitution, or protective reconfiguration is intended to reduce the consequences of failure and recover responsible future praxis.

Repair targets can include manifested conditions, relations, trust, standing, infrastructure, capacity, institutional memory, accountability, observation quality, protected options, or rule architecture. The appropriate repair depth depends on the failure decomposition. Repeated replacement of an immediate output can remain inadequate where the generating relation continues to reproduce the damage.

Definition 11.440 (Repair pathway). A *repair pathway* is an event-ordered and responsibility-linked sequence of protective, restorative, relational, institutional, epistemic, or generative actions intended to address a specified repair target while preserving uncertainty, affected positions, monitoring, and conditions for further revision.

The event-order conception is particularly useful for repair. Stabilization may need to precede investigation; acknowledgment may need to precede trust repair; restoration of capability may need to precede withdrawal of external support. Other repair actions can proceed concurrently where no precedence relation is required. The repair pathway should therefore preserve dependency relations without forcing a single total schedule.

Repair can be reparative and generative at the same time. Restoring a damaged option can also create new institutional capacity for future detection. Rebuilding trust can improve later coordination. Redesigning an accountability pathway can reduce recurrence. These effects should be evaluated explicitly rather than treating repair as mere return to a prior state.

Definition 11.441 (Repair remainder). A *repair remainder* records losses, harms, relational changes, irreversible residues, unresolved claims, or capability deficits that remain after the feasible repair pathway has been implemented.

The repair remainder matters because many histories cannot be reset. Disclosed information cannot be undisclosed; elapsed time cannot be restored; an institutional precedent can persist; trust can remain altered; a branch can remain foreclosed. Recognition of such residues prepares the compensation and exit architectures developed here and in Section 307.

11.24.8 Compensation

Compensation addresses losses or burdens that cannot be fully repaired, restored, or prevented. It should remain conceptually distinct from repair because replacement of a resource does not necessarily restore the relation, history, standing, capability, or opportunity that was lost.

Definition 11.442 (Practical compensation). *Practical compensation* is a response that transfers resources, rights, services, recognition, opportunities, capabilities, or other practical support toward affected positions in relation to intervention-associated loss or burden that remains after prevention and feasible repair.

Compensation can be material or non-material. Financial transfer can matter, but so can restored access, service provision, formal acknowledgment, procedural remedy, capability support, protected opportunity, or institutional reform. The appropriate form depends on the loss and the position of the affected subject.

Definition 11.443 (Compensation fit profile). A *compensation fit profile* records the loss or burden, affected position, degree of reparability, proposed compensation form, conversion conditions required for the compensation to become practically usable, distribution, timing, residual loss, and relation to responsibility and institutional reform.

Compensation should not become a license for preventable harm. A practical system can be poor at repair yet efficient at transferring payments after damage. Such an architecture can leave the underlying generative mechanism unchanged. Compensation therefore belongs within a broader response that includes prevention, repair, learning, and revision where relevant.

The distributional architecture also matters. Compensation can be difficult to access, delayed, conditional on burdensome proof, or unequally convertible into actual recovery. Evaluation should therefore distinguish nominal compensation from effective restoration of capability, standing, or opportunity.

Some losses remain incommensurable with the available compensation. The methodology should preserve the residual claim rather than represent a completed transfer as full equivalence. This point will become especially important in the later substantive GRE treatment of heterogeneous value transmission, conversion, return, and justice.

11.24.9 Institutional Learning

Institutional learning occurs when failure-generated knowledge changes the durable capacities through which an institution later senses, interprets, decides, acts, monitors, repairs, and revises. A report, inquiry, or after-action review can preserve information without producing institutional learning if the findings do not alter future practical architecture.

Definition 11.444 (Institutional learning from failure). *Institutional learning from failure* is a durable transformation of institutional memory, capability, rules, roles, observation regimes, responsibility pathways, or intervention methods that is traceably connected to a reconstructed failure history and improves the institution's capacity for later responsible praxis.

Learning can occur at several levels. A local implementation lesson may change a procedure. Repeated signal failure can redesign monitoring and escalation. A mechanism failure can require a new model. A representation failure can change categories or data architecture. A recurring institutional failure can change mandates, authority, or accountability. These levels should be distinguished because learning at the wrong level can leave the generating problem intact.

Definition 11.445 (Failure-learning record). A *failure-learning record* links the failure decomposition, relevant evidence, affected positions, adopted interpretation, institutional change, responsible positions, implementation status, later evaluation, and unresolved alternatives or disagreements.

Institutional learning requires memory continuity. Personnel turnover, organiza-

tional restructuring, vendor change, or political transition can sever the relation between failure and later practice. The learning record should therefore remain connected to roles, systems, and recurrent review processes rather than to the memory of particular individuals alone.

Learning also requires contestability. An institution can institutionalize an incorrect lesson from failure. Alternative interpretations, dissent, and unresolved causal claims should therefore remain accessible. Later evidence may reveal that an initially plausible lesson targeted the wrong mechanism.

Proposition 11.446 (Failure-learning adequacy). *Institutional learning from failure is adequate insofar as the organization preserves the failure history and affected positions, converts warranted lessons into durable practical capability or governance change, retains alternative interpretations where uncertainty remains, and evaluates whether the adopted change reduces recurrence without generating new failures elsewhere.*

11.24.10 Revision after Failure

Revision after failure integrates the preceding methodology. Its purpose is to determine how deeply the practical architecture should change once failure signals, harm, unintended or perverse effects, repair results, compensation limits, and institutional learning have been reconstructed. Revision should be matched to the localized failure rather than defaulting either to minimal parameter adjustment or to total abandonment.

Definition 11.447 (Failure-responsive revision architecture). *A failure-responsive revision architecture is a versioned arrangement that links a reconstructed failure to the depth and scope of practical change required in criteria, representation, model, target, mechanism, timing, scale, intervention depth, implementation, institution, monitoring, repair, compensation, or closure conditions.*

The revision can occur at several levels. A parameter can change while the mechanism remains stable. A sequence can be reordered. A target or scale can be revised. A model or observation regime can be replaced. The intervention's depth can be reduced or increased. Institutional authority can be redistributed. A protected criterion can be strengthened. The action space can be regenerated. A severe or repeated failure can justify reversal or exit.

A useful discipline is to preserve the difference between *failure correction* and *failure accommodation*. Correction attempts to address the process that generated the failure. Accommodation modifies the surrounding system so that the failure becomes tolerable or less visible while the generating process remains. Accommodation can be legitimate where correction is infeasible or disproportionate, but its status should remain explicit.

Definition 11.448 (Failure revision trigger). *A failure revision trigger is an epistemic, practical, institutional, or protective event whose occurrence satisfies the predeclared or subsequently warranted conditions for reconsidering a specified component of the intervention architecture.*

Repeated failure can also indicate that application-dominant praxis has reached an epistemic limit. Where competing explanations, unknown mechanisms, unstable models, or unresolved historical relations become central, a bounded return toward research-dominant praxis may be more responsible than repeated operational adjust-

ment. The recoupling architecture developed in Section 280 of Chapter 10 provides the conceptual basis for such a move, even when the surrounding institution continues to act on other parts of the problem.

Revision after failure should preserve the event history of earlier decisions. A later redesign does not erase the obligations created by the earlier intervention, including residual harm, compensation, repair, documentation, or responsibility. Versioning therefore connects adaptive change to accountability.

Proposition 11.449 (Failure-responsive revision principle). *Revision after failure is practically adequate insofar as the depth and object of revision correspond to the best-supported failure localization; affected positions, harm, uncertainty, and irreversible residues remain explicit; repair and compensation obligations survive redesign where relevant; and the revised architecture preserves credible pathways for further learning, reversal, and exit.*

Proposition 11.449 establishes the transition from repair-oriented adaptation to the stronger possibility that continuation of the intervention is no longer justified. Section 307 therefore develops exit and rollback as distinct practical architectures for ending, reversing, transferring, or re-entering intervention pathways while preserving residual responsibilities and historical effects.

11.25 Exit and Rollback

Section 11.24 developed failure detection and repair for cases in which an intervention, implementation process, representation, institution, or generative pathway diverges from a required practical function. The present section develops the stronger methodological architecture required when ordinary revision or repair no longer provides an adequate basis for continuation. Its role is to distinguish exit, rollback, partial reversal, withdrawal, transfer, residual responsibility, post-exit observation, and later re-entry as historically related but analytically different practical operations. Its objective is to preserve the event-ordered and relational conception developed throughout this chapter: leaving an intervention does not erase the events through which it altered subjects, relations, institutions, expectations, knowledge, and future possibilities. The discussion therefore proceeds from conditions for exit and rollback through reversibility and partial reversal, then develops orderly withdrawal, residual obligations and historical effects, post-exit monitoring, and re-entry.

Definition 11.450 (Exit architecture). An *exit architecture* is a versioned practical arrangement specifying the conditions, authority, event order, capability, transfer, protection, residual responsibility, observation, and reopening provisions through which an actor, institution, intervention, or governing arrangement can cease, withdraw from, transfer, or terminate a continuing practical commitment.

Definition 11.451 (Rollback architecture). A *rollback architecture* is a versioned practical arrangement specifying which implemented transformations are intended to be reduced, undone, restored, repaired, or replaced, together with the authority, event order, resources, reversibility limits, residual effects, and post-rollback observation required to carry out that change responsibly.

Definitions 11.450 and 11.451 distinguish two objects that are often compressed into one idea of termination. Exit changes a relation of participation, operation, authority, or support. Rollback targets one or more transformations already produced

Table 11.25: Methodological dimensions of exit and rollback.

Dimension	Primary practical object	Characteristic methodological question
Exit conditions	Continuing participation, operation, authority, or support	Which developments justify ending or transferring the present practical relation?
Rollback conditions	Implemented transformations and their consequences	Which transformations should be reduced, undone, restored, or replaced, and with what authority?
Reversibility	Recoverability of affected configurations and capabilities	Which parts of the intervention remain practically reversible, by whom, and for which affected positions?
Partial reversal	Selective restoration amid irreversible residue	Which components can be reversed while others remain historically embedded?
Orderly withdrawal	Event-ordered transition out of active involvement	Which handoffs, protections, transfers, and predecessor events are required before withdrawal?
Residual obligations	Duties surviving operational exit	Which repair, compensation, memory, maintenance, data, or responsibility obligations continue afterward?
Residual effects	Relations and historical structures remaining after exit	Which dependencies, expectations, categories, institutions, or foreclosed branches remain in the field?
Post-exit monitoring	Observation after withdrawal or rollback	Which delayed, redistributed, or residual effects remain decision-relevant after active involvement ends?
Re-entry	Later renewed participation in a changed field	Under which new conditions can re-entry occur without treating the earlier history as erased?

by the intervention. An actor can exit while the intervention remains in place under another authority; an intervention can be rolled back while the institution responsible for it remains active; and both can occur together. The distinction is necessary because the capacities, obligations, and residual consequences associated with each operation can differ substantially.

Table 11.25 summarizes the section's architecture. The dimensions should be read as coupled. A loss of reversibility can alter exit conditions; withdrawal can generate new residual obligations; rollback can create new harms requiring repair; post-exit monitoring can generate epistemic events that justify re-entry; and re-entry occurs in a field already transformed by the earlier intervention and exit history. Exit and rollback are therefore historical processes rather than administrative endpoints.

11.25.1 Exit Conditions

Exit becomes methodologically relevant when continuation of a practical relation is no longer sufficiently warranted, feasible, legitimate, safe, or responsible under the current architecture. The relevant relation can concern implementation, funding, participation, authority, service provision, governance, data operation, institutional support, or another continuing form of involvement. Exit should therefore be indexed to the practical relation being ended rather than treated as one generic project-closure event.

Definition 11.452 (Exit condition). An *exit condition* is a specified or newly recognized practical development under which ending, transferring, or terminating a continuing relation of participation, operation, authority, support, or exposure becomes sufficiently warranted to require active consideration or implementation.

Exit conditions can arise from failure, completion, loss of legitimacy, changed mandate, unacceptable harm, capability collapse, institutional succession, exhaustion of a

time-bounded commitment, emergence of a superior arrangement, disappearance of the original problem, or inability to preserve the protections on which continued action depended. They can also arise from success. A temporary intervention can properly exit because the capability it was intended to create has become self-sustaining.

An exit condition should be distinguished from an exit signal. A signal increases the relevance of an exit hypothesis; a condition provides a practical basis for serious consideration or activation of exit. The difference permits early warning and protective preparation without forcing premature withdrawal from every uncertain intervention.

Definition 11.453 (Exit-condition profile). An *exit-condition profile* records the practical relation at issue, triggering event or development, affected positions, evidential basis, uncertainty, authority, urgency, available alternatives, transfer or handoff requirements, expected residual effects, and the conditions under which the exit decision itself should be revised.

Exit conditions should be established in advance where foreseeable, especially when continuation can generate lock-in or dependence. Yet the architecture must remain open to newly recognized conditions. An intervention can reveal an affected subject omitted from the original design; an institution can lose the competence on which delegation depended; a monitoring regime can become harmful; or a new alternative can make continued exposure unnecessary. These events can justify revising the original exit logic.

The distribution of exit capacity also matters. The actor authorized to leave may differ from those who bear the consequences of departure. A funder can terminate support more easily than dependent service users can reconstruct the lost capability. A platform can discontinue an infrastructure while participants retain data, workflow, or contractual dependencies. The exit condition should therefore be evaluated from multiple affected positions rather than solely from the standpoint of the exiting actor.

Proposition 11.454 (Exit-condition adequacy). An *exit condition* is *practically adequate* insofar as it identifies the relation being ended, connects the triggering development to affected positions and available alternatives, represents transfer and residual consequences, and preserves sufficient authority, capability, and revision pathways for an orderly transition rather than treating departure itself as completion of responsibility.

11.25.2 Rollback Conditions

Rollback concerns implemented transformation rather than participation alone. Its object can be a rule, infrastructure, classification, data practice, institutional arrangement, resource commitment, technical system, relational configuration, or another intervention-produced change. Rollback becomes relevant when continuation or ordinary modification of that transformation is less supportable than reduction, restoration, replacement, or deliberate reconstruction.

Definition 11.455 (Rollback condition). A *rollback condition* is a specified or newly recognized practical development indicating that one or more implemented transformations should be actively considered for reduction, restoration, replacement, termination, or reconstruction, subject to the actual reversibility and residual-consequence profile of the affected field.

Rollback conditions can include material harm, mechanism failure, loss of legal or institutional authorization, unacceptable distributional consequences, erosion of generative capacity, newly discovered model failure, loss of monitoring or repair capability, or evidence that the intervention is producing a history substantially outside its warranted commitment envelope. A rollback condition can also arise before realized harm if the intervention loses the protective conditions on which its original warrant depended.

Rollback should not be equated with mechanical inversion. Suppose an intervention transformation is represented by Φ and produces the later configuration $\omega' = \Phi(\omega)$. A practical rollback operation Ψ generally satisfies Equation 11.54 rather than restoring the original configuration exactly.

$$\Psi(\Phi(\omega)) \neq \omega. \quad (11.54)$$

Equation 11.54 expresses historical non-restoration rather than a universal algebraic theorem. Between Φ and Ψ , subjects can learn, information can be disclosed, expectations can change, institutions can adapt, alternatives can disappear, and new relations can form. A formal inverse may therefore be unavailable, institutionally infeasible, normatively inappropriate, or practically meaningless even where a technical rollback procedure exists.

Definition 11.456 (Rollback-condition record). A *rollback-condition record* documents the target transformation, triggering event, affected positions, rollback objective, feasible restoration depth, event-order dependencies, capability and authority requirements, expected residual effects, repair or compensation needs, uncertainty, and post-rollback monitoring conditions.

Rollback can itself generate harm. Removing a system can interrupt services; reversing a classification can create administrative uncertainty; restoring an earlier rule can reactivate an older injustice; dismantling infrastructure can destroy capability that became valuable independently of the original intervention. The method should therefore compare the consequence histories of continuation, ordinary revision, rollback, replacement, and exit rather than treating rollback as a costless default once failure is detected.

11.25.3 Reversibility

Reversibility is the practical capacity that makes rollback more than a nominal promise. It depends on technical design, institutional authority, retained resources, records, alternative infrastructure, repair capability, affected-position protections, and the historical depth of adaptation around the intervention. A technically undoable operation can become practically irreversible if no authorized actor possesses the resources or standing to reverse it.

Definition 11.457 (Exit-rollback reversibility profile). An *exit-rollback reversibility profile* records, for each materially relevant intervention component and affected position, the degree of recoverability, authority to reverse, required predecessor events, resources, alternative capacity, expected duration, residual effects, repair burden, and the conditions under which reversibility is expected to decay.

Reversibility is positional. The institution can restore its own configuration while affected subjects remain unable to recover lost opportunity, disclosed information,

damaged trust, or altered standing. Conversely, an affected subject can exit a service while the provider remains locked into infrastructure or contractual commitments. The profile should therefore avoid describing an intervention as simply “reversible” without identifying for whom and with respect to what object.

Reversibility is also event-ordered. A rollback operation can require preservation of records before data migration, capability transfer before support withdrawal, institutional authorization before infrastructure restoration, or repair before termination. Some requirements can remain concurrent, while others form strict generative precedence relations. Clock time can label these events where operationally useful, but the practical architecture is determined by the predecessor relations required for credible recovery.

Definition 11.458 (Reversibility reserve). A *reversibility reserve* is the set of resources, authority, records, capabilities, alternatives, infrastructure, institutional memory, and protected practical options intentionally preserved so that rollback, withdrawal, repair, or replacement remains materially possible if later events justify it.

The reserve can decay. Complementary investment, personnel turnover, institutional specialization, migration of data, loss of alternative providers, dependency formation, and legal or technical lock-in can make an intervention progressively harder to reverse. Monitoring reversibility therefore belongs inside the intervention lifecycle rather than being postponed until exit becomes necessary.

Proposition 11.459 (Reversibility preservation). *Where a consequential intervention derives part of its practical warrant from the possibility of later correction, its governance should preserve and periodically reassess the authority, capability, memory, alternatives, and affected-position protections required for meaningful rollback or exit as long as those possibilities remain decision-relevant.*

11.25.4 Partial Reversal

Many interventions can be reversed only in part. Some technical components can be removed while institutional categories persist. Funding can cease while expectations and dependencies remain. A rule can be formally repealed while records, incentives, or precedents continue to shape later practice. Partial reversal should therefore be treated as a normal methodological case rather than an imperfect approximation to complete restoration.

Definition 11.460 (Partial reversal). A *partial reversal* is a rollback operation that materially reduces or reconstructs one or more implemented transformations while other intervention-generated changes, consequences, relations, obligations, or historical residues remain in the practical field.

Definition 11.461 (Reversal frontier). A *reversal frontier* records the boundary between intervention-generated changes that remain feasibly reversible under the present architecture, changes that require repair or substitution rather than direct reversal, and changes that are effectively irreversible within the relevant practical horizon.

The reversal frontier can move. An early intervention stage can be highly reversible; later complementary investments can move components across the frontier. New technology, institutional reform, or restored capability can sometimes move a

previously irreversible component back toward practical recoverability. The frontier should therefore be versioned rather than treated as fixed at design time.

Partial reversal can be selective in depth. An institution can retain beneficial capacities generated by the intervention while removing a harmful rule. A representation regime can preserve a useful dataset while abandoning a stigmatizing classification. A relational arrangement can retain coordination while redistributing authority. The objective is not necessarily to approximate the exact pre-intervention state, but to reconstruct a more supportable configuration while explicitly recording what remains.

The repair remainder developed in Section 11.24 is central here. A partial reversal should produce a *reversal remainder* identifying irreversible effects, unresolved claims, residual dependencies, foreclosed options, and consequences whose attribution remains uncertain. This prevents a successful technical rollback from being narrated as complete restoration where the historical field remains transformed.

Definition 11.462 (Reversal remainder). A *reversal remainder* is the set of materially relevant intervention-generated effects, obligations, uncertainties, relational changes, capability changes, and historical residues that persist after the feasible rollback or restoration operation has been completed.

11.25.5 Orderly Withdrawal

Withdrawal concerns the cessation or transfer of continuing practical involvement. Its quality depends on the transition architecture between active support and the post-withdrawal field. Abrupt withdrawal can convert a previously manageable intervention into a capability, maintenance, or responsibility failure. An orderly withdrawal therefore treats handoff, continuity, protection, and memory as part of exit rather than as optional administrative closure tasks.

Definition 11.463 (Orderly withdrawal pathway). An *orderly withdrawal pathway* is an event-ordered transition through which active intervention, support, operation, authority, or participation is reduced or transferred while specified protections, capability handoffs, information continuity, responsibility transfers, repair obligations, and post-withdrawal observation remain sufficiently preserved.

The pathway can contain events such as notification, consultation, transfer of records, capability development, authorization of a successor, testing of fallback arrangements, transfer of assets or maintenance responsibility, final operational withdrawal, and post-withdrawal review. Their order should reflect actual dependencies. Capability handoff may need to precede termination of technical support; responsibility acceptance may need to precede transfer of operational authority; affected-subject notification can need to precede data migration or service closure.

The event structure can remain partially ordered. Several transfers can occur concurrently. Some observation events can continue after operational withdrawal. A successor institution can begin adaptation before the exiting actor fully leaves. The method should represent these relations without imposing a total sequence where none is required.

Withdrawal should also distinguish *transfer* from *abandonment*. Transferring responsibility is not achieved by merely naming a successor. The successor must possess or acquire sufficient authority, capability, resources, information, and practical opportunity to assume the role. A nominal transfer that leaves these conversion con-

ditions absent can create a responsibility gap while allowing the exiting actor to describe the transition as complete.

Definition 11.464 (Withdrawal handoff record). A *withdrawal handoff record* documents the responsibilities, assets, capabilities, information, records, authority, dependencies, unresolved risks, affected positions, receiving subjects or institutions, acceptance conditions, predecessor events, and residual obligations associated with the transition out of active involvement.

Orderly withdrawal can also require deliberate reduction of dependence before exit. If the intervention has generated a relation in which affected subjects cannot sustain the relevant function independently, the exit architecture can include capability transfer, diversification, redundancy, or alternative access as predecessor conditions. This is especially important where the intervention itself created the dependence.

11.25.6 Residual Obligations

Operational exit does not necessarily terminate responsibility. Earlier action can generate obligations that persist after funding, authority, implementation, or participation ends. These obligations can concern repair, compensation, maintenance, data, information, records, capability, environmental restoration, accountability, or long-horizon monitoring.

Definition 11.465 (Residual obligation). A *residual obligation* is a responsibility generated or preserved by an earlier practical relation or intervention history that remains materially relevant after operational exit, withdrawal, rollback, transfer, or formal project closure.

Residual obligations should be linked to the history that generated them. They are not simply indefinite moral claims attached to every past intervention. A maintenance obligation can follow from infrastructure introduced by the intervention. A compensation obligation can follow from realized harm. A data obligation can follow from information collected under an earlier observation regime. A memory obligation can follow from risks that later actors need to understand. The practical relation between earlier action and later responsibility should remain traceable.

Definition 11.466 (Residual-obligation ledger). A *residual-obligation ledger* records each surviving obligation, its historical basis, responsible position, affected positions, required action or resource, temporal or event-order condition, transferability, monitoring requirement, completion criterion, and unresolved uncertainty or contestation.

Transfer of an obligation should preserve both capacity and accountability. A departing actor can finance a successor's maintenance responsibility, transfer records, retain liability for specified harms, or share responsibility during a transition period. The architecture can therefore contain layered responsibility rather than forcing a single post-exit owner immediately.

Some obligations may persist without a determinate completion date because their object is event-conditioned. Monitoring can continue until a delayed consequence becomes sufficiently resolved; data stewardship can persist until lawful deletion, transfer, or archival conditions are met; repair can remain open until an affected capability is restored or an explicitly preserved remainder is acknowledged. Event-order conditions can therefore be more appropriate than arbitrary calendar endpoints.

Proposition 11.467 (Residual-responsibility continuity). *Exit is responsibility-preserving insofar as obligations generated by the intervention history remain traceable to capable and accountable positions until they are discharged, legitimately transferred, transformed into another responsibility, or preserved as an explicitly unresolved residual claim.*

11.25.7 Residual Relational and Historical Effects

Exit changes the field but does not remove the historical fact that the intervention occurred. Relations, expectations, categories, infrastructures, knowledge, habits, obligations, and action-space changes can continue after active involvement ends. Evaluation should therefore distinguish the end of the focal intervention from the end of its generative consequences.

Definition 11.468 (Post-exit relational-historical profile). *A post-exit relational-historical profile records materially relevant relations, institutional arrangements, subject transformations, representations, dependencies, capacities, constraints, expectations, action-space changes, history-space changes, and unresolved claims that persist after operational exit or rollback.*

Residual effects can be beneficial, harmful, or mixed. A pilot can leave useful institutional memory after closure. A withdrawn service can leave trained staff and durable coordination. A failed classification system can leave stigmatizing categories in records. A temporary intervention can create expectations that alter later legitimacy. The methodology should preserve this heterogeneity rather than assuming that residuality is synonymous with damage.

The historical-relational subject architecture is particularly important here. Subjects who participated in the intervention can carry new capabilities, classifications, memories, expectations, or institutional relations after exit. In a partially ordered or 2-complex representation, the exit event becomes one event in the subject's continuing history rather than a deletion of the earlier vertices and relations. Later action therefore begins from an historically transformed subject.

Exit can also alter the action space of actors who remain. The departure of one institution can foreclose coordination options, free resources, generate local autonomy, or create new dependencies. These changes belong to the exit consequence structure even where the exiting actor is no longer operationally present.

Definition 11.469 (Exit consequence remainder). *An exit consequence remainder records the materially relevant post-exit effects that remain unresolved, difficult to attribute, effectively irreversible, or not yet representable within the dominant evaluation architecture.*

Preserving the remainder protects against an administrative fiction in which closure documentation erases the continuing historical field. It also creates an evidential basis for later post-exit monitoring, institutional learning, responsibility review, or re-entry.

11.25.8 Post-Exit Monitoring

Post-exit monitoring extends observation beyond the end of active intervention where delayed, redistributed, residual, or uncertain consequences remain practi-

cally relevant. Its purpose is not to maintain indefinite control over the field, but to preserve enough epistemic access to discharge residual responsibilities, detect delayed harm, evaluate rollback, and determine whether further repair, re-entry, or responsibility transfer becomes necessary.

Definition 11.470 (Post-exit monitoring regime). A *post-exit monitoring regime* is a bounded observation architecture maintained after withdrawal, rollback, transfer, or termination in order to observe specified residual obligations, delayed effects, relational or historical consequences, rollback performance, and conditions for discharge, repair, re-entry, or renewed inquiry.

The regime should inherit the proportionality discipline of Section 11.21. Monitoring after exit can impose surveillance, reporting burden, dependency, or continued institutional influence precisely when the purpose of exit was to reduce intervention. The observation architecture should therefore identify why each monitored object remains decision-relevant, who bears the burden, who receives the information, and when the observation relation itself should end.

Post-exit observation can remain event-triggered. A review can occur after a successor assumes responsibility, after a rollback stage is completed, when an early-warning event appears, when a delayed effect becomes observable, or when an affected subject invokes a contestability pathway. Uniform periodic monitoring is only one possible implementation.

Monitoring results can generate new epistemic events. Evidence of persistent harm can reopen repair or compensation. Evidence that a transfer failed can reactivate transition support. Discovery of an unanticipated beneficial capacity can alter the interpretation of the exit history. A new representation can reveal that the earlier rollback targeted the wrong mechanism. Post-exit monitoring should therefore preserve the same typed distinction between readout, interpretation, institutional uptake, and practical transformation developed earlier in the chapter.

Definition 11.471 (Post-exit discharge condition). A *post-exit discharge condition* is a specified event or practical state under which a residual monitoring, maintenance, repair, data, or responsibility obligation can be closed, transferred, or reduced because the relevant protected condition, uncertainty, or consequence has become sufficiently resolved.

A discharge condition prevents post-exit governance from becoming indefinite by default while preserving the possibility that some responsibilities legitimately continue until an event rather than a fixed date occurs.

11.25.9 Re-Entry

Re-entry concerns renewed practical involvement after an earlier exit, withdrawal, transfer, or rollback. It should not be represented as return to the original intervention state because the field, subjects, institutions, action space, and knowledge architecture can all have changed during the intervening history. Re-entry is therefore a new practical commitment with historical continuity, rather than restoration of an erased past.

Definition 11.472 (Re-entry condition). A *re-entry condition* is a specified or newly recognized development under which renewed participation, support, authority, operation, or intervention by a previously exited actor or arrangement becomes suffi-

ciently relevant and supportable to require practical consideration.

Possible re-entry conditions include failure of a successor arrangement, newly realized residual harm, emergence of a capability that makes a previously unsafe intervention supportable, renewed request from affected subjects, a new mandate, transformed institutional conditions, or an epistemic event that substantially changes the interpretation of the earlier exit. Re-entry can also occur for repair or knowledge purposes without restoring the original intervention.

Definition 11.473 (Re-entry dossier). A *re-entry dossier* links the earlier intervention and exit history to the present practical configuration, documenting what has changed in subjects, relations, institutions, action spaces, evidence, values, authority, capabilities, obligations, residual effects, and the proposed scope and conditions of renewed involvement.

The event-order architecture is essential. The earlier intervention, exit, residual-history events, and re-entry are connected through one historical structure. Re-entry therefore inherits the consequences of the earlier branch. It cannot assume that the former action space, legitimacy, trust, or capability can be restored merely by reinstating an earlier policy or institution.

Re-entry also requires attention to power and dependence. A system in which an actor repeatedly exits and re-enters can prevent local capability formation or create strategic dependency. Conversely, a protected re-entry pathway can increase safety by allowing temporary withdrawal without forcing irreversible abandonment. Whether re-entry is generative or dependency-producing depends on the relations and capacities that the architecture creates.

Proposition 11.474 (Exit–re-entry continuity). *Re-entry is methodologically adequate insofar as it is evaluated as a new commitment in a historically transformed field, preserves the provenance and residual obligations of the earlier intervention and exit, reconstructs current subjects, institutions, evidence, and action spaces, and establishes fresh conditions for authority, monitoring, revision, rollback, and future exit.*

The exit and rollback methodology developed in this section completes the chapter's treatment of intervention lifecycle governance. Diagnosis, decision, design, experiment, monitoring, evaluation, failure response, repair, rollback, exit, and re-entry now form a connected event-ordered architecture. The next section turns to AI-assisted decision support. Its task is to examine how machine-generated representations, recommendations, simulations, and epistemic events can participate in this architecture while preserving human responsibility, model plurality, traceability, contestability, and the possibility of revision or withdrawal.

11.26 Selected Boundaries of Evidence-to-Decision Systems

The role of this section is to identify several conditions under which a formally specified evidence-to-decision system can remain practically incomplete even when its data, models, optimization procedures, and computational implementation are internally coherent. Its objective is neither to reject formal decision support nor to reserve final judgment to an undefined residual intuition. It develops six illustrative and recurring boundary conditions that can require practical judgment, institutional

responsibility, historical interpretation, human-relational attention, or recursive revision beyond the formal mapping from evidence to recommended action. The six are examples selected because they recur in the present chapter; they are not proposed as an exhaustive taxonomy of the limits of formal decision systems. Other domains and future methodological developments may disclose additional boundary conditions. The discussion proceeds through evidential–normative underdetermination, responsibility retention, human-relational distance, temporal and historical transport, regime-sensitive reliability near critical transitions, and reflexive or performative feedback. The method is meta-methodological. AI-assisted systems, statistical models, optimization pipelines, scoring systems, simulations, and other formal decision infrastructures appear as possible instances of the broader architecture rather than as the section’s primary substantive object.

A formal evidence-to-decision system can be highly useful. It can assemble heterogeneous data, generate forecasts, estimate causal effects, compare scenarios, optimize a specified objective, search large design spaces, and apply decision rules consistently. Its practical authority nevertheless depends on relations that formal closure can leave outside the model: how a goal acquired standing, who bears responsibility for consequences, which aspects of a subject survive representation, whether evidence still transports across historical change, whether the response regime remains stable, and whether deploying the system changes the field it observes.

Definition 11.475 (Formal evidence-to-decision system). A *formal evidence-to-decision system* is a specified arrangement through which represented evidence is transformed by one or more formal, statistical, computational, rule-based, or model-mediated procedures into a decision-relevant ranking, recommendation, classification, trigger, action proposal, or automated action.

Definition 11.476 (Formal decision closure). *Formal decision closure* is the condition in which the represented evidence, evaluative rules, model structure, and decision procedure are treated as sufficient to determine practical commitment within the scope claimed for the system.

Formal decision closure can be appropriate for tightly bounded tasks whose goals, constraints, authority, and response structure are stable enough for the intended purpose. The boundary conditions developed below concern cases in which one or more of those relations remain materially open. They therefore qualify the scope of formal closure without implying that formal methods lack practical value.

Table 11.26 summarizes the six boundary conditions. The retained label reflects the historical development of the chapter source; the table itself now concerns formal evidence-to-decision systems generally.

The six conditions in Table 11.26 can overlap and should be read as a partial map rather than a completed list. A machine-mediated classification can compress a subject, redistribute responsibility, alter eligibility, and generate a new data distribution simultaneously. A policy model can rely on historically transported evidence while the public release of its forecast changes expectations. The purpose of the taxonomy is analytical separation, not the claim that practical failures arise one at a time.

11.26.1 Evidential–Normative Underdetermination

Evidence can constrain practical belief without independently determining practical ends. A model can estimate expected outcomes, causal effects, risks, distributions, or

Table 11.26: Six illustrative boundary conditions of formal evidence-to-decision systems.

Boundary condition	Practical remainder outside formal closure	Methodological implication
Evidential–normative underdetermination	Evidence can inform consequences without independently establishing which ends, rights, risks, or distributions should govern commitment	Preserve normative provenance and distinguish inference from practical authorization
Responsibility retention	Models and delegated systems can contribute to action without themselves bearing institutional or moral responsibility	Maintain identifiable duties of authorization, verification, monitoring, repair, and consequence management
Human-relational distance	Formal representations can compress lived history, recognition, meaning, agency, and relational position into administratively tractable proxies	Preserve affected-subject access, interpretive remainder, contestability, and proportionate human judgment
Temporal and historical transport	Evidence generated under one configuration can lose applicability after institutional, technological, relational, or population change	Time-stamp validity claims and reopen transport assumptions when the field changes
Regime-sensitive reliability	Stable-regime models can lose practical reliability near a qualitative transition or under model uncertainty about such a transition	Couple formal output to transition-sensitive monitoring, model plurality, and staged commitment
Reflexive / performative feedback	Use of a classification, forecast, score, recommendation, or rule can change the field that later generates evidence	Treat deployment as part of the history and revise models after consequential uptake

transition probabilities. The move from those estimates to action also requires judgments about which outcomes matter, how risks are distributed, which rights or protections constrain action, whose claims possess standing, which temporal horizons count, and what kinds of loss remain unacceptable.

This boundary condition corresponds to the familiar structure often described through the distinction between descriptive and normative propositions. The methodological point can be stated without requiring a universal theory of value: an evidential statement concerning what is, has been, or is likely to occur does not by itself contain the practical rule that selects what ought to be pursued. Formal systems can incorporate normative commitments, but the commitments then enter as assumptions, objective functions, constraints, priorities, labels, or decision rules

whose provenance remains a separate object of analysis.

Definition 11.477 (Normative input surface). A *normative input surface* is the set of value judgments, rights, protections, distributional priorities, acceptable-risk judgments, temporal priorities, and practical orientations that enter a formal evidence-to-decision system explicitly or implicitly and thereby condition its recommendations.

A normative input can be democratically authorized, legally mandated, institutionally inherited, professionally justified, negotiated among affected positions, or provisionally adopted for exploration. The formal system can help reveal the consequences of those commitments. It cannot erase the need to explain their standing.

The distinction also prevents technical performance from being mistaken for practical legitimacy. A system can estimate a specified objective with high accuracy while the objective itself remains contested. A formally optimal allocation can remain unacceptable because a protected relation or unrepresented value is omitted. Section 11.3 therefore remains logically prior to formal comparison: evaluative frames are historically situated inputs to decision systems, not outputs produced automatically by evidence.

11.26.2 Responsibility Distribution and Retention

Formal and machine-mediated decision systems distribute practical agency across designers, data producers, model developers, institutional owners, operators, reviewers, affected subjects, and authorizing bodies. This distribution can improve specialization and consistency. It can also make responsibility difficult to locate when each participant controls only one part of the decision chain.

Definition 11.478 (Responsibility vacancy). A *responsibility vacancy* arises when a consequential decision process distributes epistemic, technical, institutional, and operational functions in a way that leaves one or more materially relevant duties of authorization, verification, monitoring, explanation, correction, repair, or consequence management without an identifiable bearer possessing sufficient capacity and authority to discharge them.

The problem is therefore stronger than mere diffusion. Shared responsibility can be legitimate when duties remain identifiable. Vacancy appears when a model is treated as if it bears the responsibility of the institution using it, when a vendor controls a consequential component without access to downstream effects, when operators are instructed to follow recommendations they are not authorized to challenge, or when affected subjects have no institution capable of correcting an error after deployment.

Formal systems can support responsibility through provenance, audit logs, role separation, independent review, escalation rules, and versioning. These devices are useful only when connected to actual authority and capacity. A detailed log without a responsible institution can document failure without creating a route for remedy.

Proposition 11.479 (Responsibility retention). *Delegation of observation, inference, simulation, optimization, recommendation, or execution should preserve identifiable responsibility relations proportionate to the consequences of the delegated function, including routes for verification, authorization, correction, and repair where these are materially relevant.*

Proposition 11.479 applies to AI systems as one contemporary case, but its scope

is wider. Committees, consultants, scoring rules, outsourced analytics, bureaucratic procedures, and automated control systems can generate the same structural problem.

11.26.3 Human-Relational Distance and Representational Compression

Formal decision infrastructures operate through representations. They encode subjects, histories, relations, preferences, capacities, harms, and claims in forms that can be compared or processed. Such compression is often necessary for coordination at scale. The boundary condition arises when the practical authority of the representation exceeds its capacity to preserve aspects of lived and relational reality that are material to the decision.

The term *human-relational distance* is used here instead of assuming a fixed essence of “humanity.” The concern is relational: decision processes can become increasingly separated from the persons, communities, practices, meanings, and histories whose consequences they organize. A subject can appear primarily as a score, eligibility state, predicted risk, feature vector, administrative case, or optimization unit. These representations can be appropriate for some tasks while remaining incomplete for others.

Definition 11.480 (Human-relational distance). *Human-relational distance* is the degree to which the representation, decision pathway, and authority structure of a formal decision system separate consequential judgment from the historically situated meanings, agency, recognition, testimony, relations, and practical experience of the affected subjects relevant to that judgment.

Distance is not automatically harmful. Standardization can reduce arbitrary treatment, make large systems governable, and protect individuals from inconsistent personal judgment. The methodological question concerns fit. A highly compressed representation can be adequate for a routine logistics decision and inadequate for a decision whose consequences depend on historical obligation, dignity, care, identity, trust, or context-specific meaning.

Several safeguards can reduce harmful distance without rejecting formalization. Affected-subject testimony can remain available alongside scores. Explanations can identify which representation drove a decision. Contest routes can permit correction of category mismatch. Human review can be allocated to cases where interpretive remainder is material. Participatory design can influence which variables and outcomes enter the system. Historical-relational subject reconstruction from Sections 11.7 and 11.13 can also preserve structures that a point-like representation suppresses.

The concern is therefore compatible with methodological pluralism. Human judgment is itself fallible, situated, and potentially biased. The meta-framework does not idealize unformalized discretion. It requires a proportionate relation among formal representation, lived and historical access, institutional responsibility, and contestability.

11.26.4 Temporal and Historical Transport of Evidence

Formal decision systems often rely on evidence generated before the decision. Training data, historical outcomes, estimated causal effects, calibrated parameters, institutional records, or expert rules can all encode earlier configurations. Their practical validity depends on whether the relations generating those observations remain sufficiently comparable to the field in which the system is now used.

Definition 11.481 (Temporal evidence mismatch). A *temporal evidence mismatch* occurs when evidence generated under an earlier historical-relational configuration is used to support a current commitment while changes in population, institution, technology, classification, behavior, observation, mechanism, or prior intervention materially weaken the transport of the relevant claim.

Temporal mismatch is broader than statistical drift. The field can change in ways that do not appear immediately in marginal data distributions. Legal categories can be redefined. An institution can alter incentives. A technology can create new capabilities. A public model can change behavior. An earlier intervention can select which cases remain observable. A historical process can shift the meaning of the measured variable itself.

The evidence-transport profile from Section 11.4 provides the general method for recording these conditions. Formal systems add a versioning requirement because data pipelines, model parameters, prompts, retrieval corpora, optimization rules, and software dependencies can change at different times from the field being modeled. A recommendation should therefore be linked to the epistemic and computational state that produced it when later consequences require reconstruction.

Temporal validity can also expire during implementation. A model that justified initiation can become weakly relevant after the intervention changes the field. Monitoring should therefore include assumptions about transportability, not only outcome indicators.

11.26.5 Regime-Sensitive Reliability near Critical Transitions

Formal systems can be reliable within one response regime and fragile near a qualitative transition. A statistical relationship calibrated under relative stability can lose transportability; a local optimization can identify an excellent solution inside a basin that is becoming inaccessible; a causal mechanism can change after institutional reorganization; a simulation can omit the transition mechanism that becomes decisive.

Section 11.11 developed critical-transition uncertainty as a model-relative practical problem. The boundary condition for formal evidence-to-decision systems is therefore specific: evidence and models validated under one regime do not automatically establish reliability when the decision itself can approach, induce, or cross a regime boundary.

Definition 11.482 (Regime-sensitive model authority). *Regime-sensitive model authority* is the degree of practical reliance warranted for a formal model after considering the response regime in which it was validated, uncertainty about the current regime, plausible qualitative transitions, and the consequences of model failure across those regimes.

This concept does not require the analyst to prove that the field is near criticality. It requires model authority to weaken or become more conditional when transition

uncertainty becomes materially decision-relevant. The appropriate response can include model plurality, transition-sensitive indicators, stress tests, staged action, preserved options, local validity domains, or greater human and institutional review.

Formal models can also be especially valuable near transition. Dynamical analysis, simulation, network models, and sensitivity analysis can reveal mechanisms invisible to ordinary linear extrapolation. The qualification concerns the interpretation of their authority, not their exclusion.

11.26.6 Reflexive and Performative Feedback

The sixth boundary condition arises when the output of a formal system becomes part of the causal field it represents. A score can change access, a forecast can alter expectations, a recommendation can coordinate actors, a model-based threshold can change institutional behavior, and an automated action can reshape the data distribution used for later learning. The evidence-to-decision system then participates in its own future evidence-generating process.

Definition 11.483 (Decision-system performativity). *Decision-system performativity* is the practical condition in which the production, communication, institutional recognition, or implementation of a formal decision output contributes materially to changes in the relations, behavior, constraints, capacities, classifications, expectations, or observations that later constitute the system's evidential environment.

The recursive structure can be described in ordinary language. A field generates evidence; evidence enters a representation; the representation supports a decision; the decision changes the field; and the changed field generates later evidence. The important methodological point is that the later evidence belongs to a different history. Treating it as an independent sample from the pre-deployment process can conceal the effect of the decision system itself.

Performativity can generate apparent success or apparent failure. A warning model can appear over-pessimistic because actors responded to the warning and prevented the forecast event. A ranking system can appear predictive because institutions allocate resources in ways that reinforce the ranking. A recommendation system can narrow exposure and later learn from the population it helped select. Evaluation should therefore preserve the deployment and uptake history when these feedbacks are plausible.

Proposition 11.484 (Open evidence-to-decision architecture). *A formal evidence-to-decision system can be methodologically stronger when its practical use preserves the boundary conditions relevant to its field. The six conditions developed here—normative provenance, responsibility retention, representational remainder, temporal transport, regime sensitivity, and performative feedback—provide an illustrative set. Additional conditions can become relevant in other practical configurations. Relevant boundary conditions can be handled inside, alongside, or around the formal system, while their practical standing remains visible and revisable.*

Proposition 11.484 explains why the chapter does not seek a fully closed decision machine. Formal methods can carry substantial parts of diagnosis, inference, simulation, optimization, and recommendation. Practical closure remains a historically situated institutional act whose adequacy depends on relations that can extend beyond formal representation.

AI-assisted decision support now fits naturally within this architecture. AI systems can generate scenarios, forecasts, classifications, summaries, optimization proposals, or recommendations, and can also mediate observation and communication. Their specific technical and epistemic properties should be analyzed where relevant, while the general methodological questions of responsibility, human-relational distance, historical transport, regime sensitivity, and performative uptake already apply at the domain-general level. The substantive economic and political-economic consequences of radical human–AI capability asymmetry remain the work of Chapter 18.

Section 11.27 integrates the chapter’s methodological repertoire after these boundary conditions have been made explicit. The integrated architecture therefore cannot be interpreted as a fixed pipeline that converts evidence into action. It is a configurable and recursive practical system whose components, responsibilities, models, evaluative frames, and reopening conditions can change through history.

11.27 Integrated Intervention Design

This section integrates the methodological components developed across Chapter 11 into a configurable recursive architecture for practical intervention. Its role is synthetic: the objective is to show how diagnosis, practical–epistemic situation mapping, reconstruction of historical-relational subjects, situated practical orientation, epistemic conditions, methodological composition, generative history construction, decision, intervention, monitoring, evaluation, model revision, action-space revision, and exit can be related without converting their relations into a mandatory universal workflow. The discussion uses one structural organization to expose interfaces, reopening conditions, and provenance requirements while allowing projects to omit, combine, reorder, deepen, or replace components according to their field and commitment profile. The resulting architecture is a domain-general coordination framework and an open methodological proposal that can later be instantiated in economic praxis.

Definition 11.485 (Integrated intervention architecture). An *integrated intervention architecture* is a versioned practical design that connects the subset of diagnosis, practical–epistemic situation mapping, historical-relational subject reconstruction, situated practical orientations, evaluative frames, epistemic conditions, methodological composition, generative history spaces, decision procedures, intervention mechanisms, monitoring, evaluation, representation revision, action-space revision, and exit or rollback conditions that are materially relevant to a particular commitment through explicit responsibility, provenance, and reopening relations.

Integration therefore concerns explicit relations among selected practical objects, not completion of a fixed sequence. A small reversible intervention can use a compact architecture, while a deep institutional intervention can require multiple interacting models, participatory structures, staged authorization, independent monitoring, and long post-exit obligations. A revised diagnosis can reopen the evaluative frame; a new epistemic event can alter the estimated history space; a failure signal can change the action set; a model revision can invalidate a recommendation; and an exit event can create residual obligations that become part of a later diagnosis. Other projects can organize these relations differently when their practical history warrants a different order.

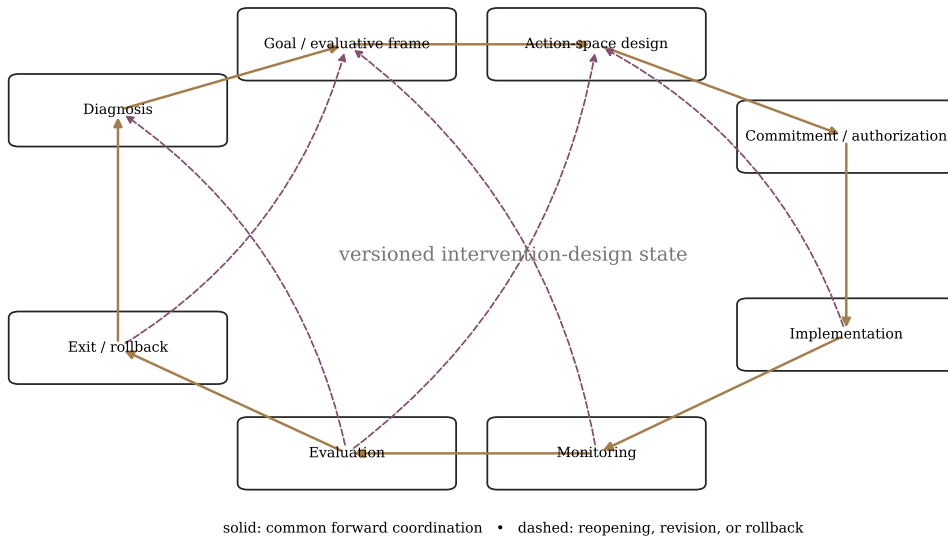


Figure 11.1: One configurable representation of integrated intervention design. The forward path depicts a common coordination route from diagnosis toward implementation and evaluation; the dashed paths show selected routes for reopening commitment or entering exit and rollback procedures. Projects can omit, combine, reorder, or deepen components according to the practical field. The diagram serves a methodological purpose while leaving ontology suspended.

Figure 11.1 presents one possible coordination architecture as a recursive cycle. The forward path depicts a common movement from practical reconstruction toward commitment and implementation; it is illustrative rather than mandatory. The return paths represent the possibility that monitoring, evaluation, model revision, action-space revision, or post-exit consequences change the practical situation itself. The figure therefore visualizes one way to coordinate coupled epistemic and practical events while the text preserves alternative orderings and project-specific omissions.

A useful way to preserve this architecture across revision is to treat the current practical design as a versioned state. Let D_k denote the documented intervention-design state at revision step k , let E_k denote newly admitted evidence and epistemic events, let O_k denote observations generated during implementation, and let C_k denote relevant changes in constraints, capacities, relations, institutions, or external conditions. The update relation is stated in Equation 11.55.

$$D_{k+1} = \mathcal{U}(D_k, E_k, O_k, C_k), \quad (11.55)$$

where $\mathcal{U}$ denotes the documented revision procedure appropriate to the project. Equation 11.55 is a project-level bookkeeping formalization with locally specified semantics. Its purpose is to make explicit that the intervention architecture itself is one of the objects that can evolve. The contents of D_k can include qualitative

interpretations, participatory records, formal models, institutional rules, legal constraints, model versions, alternative histories, and responsibility assignments. Different projects can therefore instantiate the update procedure through different methodological traditions.

Proposition 11.486 (Integrated traceability). *An intervention design becomes more methodologically accountable when materially consequential changes in diagnosis, goals, evidence, model assumptions, action spaces, implementation, or exit conditions can be traced to the events and judgments that produced the corresponding design revision.*

The remainder of the section develops each component of this architecture and specifies its principal interfaces with the others.

11.27.1 Diagnosis

Diagnosis supplies the initial practical reconstruction on which the rest of the intervention architecture depends. Section 11.2 developed practical diagnosis as a structured inquiry into conditions, relations, constraints, capacities, asymmetries, uncertainties, and possible mechanisms. Within integrated design, diagnosis acquires an additional role: it becomes the first versioned object against which later changes can be interpreted. A project should therefore record both what is believed about the practical field and how that belief was produced.

Definition 11.487 (Integrated diagnostic state). *An integrated diagnostic state is a versioned reconstruction of the practical field that records the focal condition, relevant relations, constraints, capacities, asymmetries, historical processes, uncertainties, observation gaps, candidate mechanisms, affected positions, and the evidence and interpretive procedures supporting those elements.*

The diagnostic state should distinguish at least three kinds of uncertainty. The first concerns incomplete observation: relevant events, relations, or positions can remain poorly observed. The second concerns interpretive uncertainty: the same records can support multiple historical or causal reconstructions. The third concerns practical uncertainty: even a well-described field can respond unpredictably to intervention because the intervention changes relations, expectations, incentives, classifications, or capacities. Keeping these uncertainties distinct helps determine whether the appropriate next action is additional observation, comparative interpretation, formal modeling, a pilot intervention, participatory inquiry, or deliberate preservation of flexibility.

Diagnosis also requires a boundary decision. The practical field can rarely be represented exhaustively. Integrated design should therefore identify which relations, scales, histories, and neighboring systems are treated as internal to the current analysis and which are represented as external conditions. Boundary choices should be revisable because intervention can create new dependencies. A local program can become institutionally coupled to a wider funding regime; a technological intervention can create infrastructural dependence; a classification can change who is administratively recognized as a member of the target population.

The diagnostic state should contain an uncertainty and omission register. An omission is methodologically different from a finding of absence. If a group, relation, or historical process is weakly represented because the observation system does not capture it, the integrated design should preserve that limitation. Subsequent model out-

puts, scenario families, or recommendations can then preserve the weakly observed status of the omitted material explicitly.

Diagnosis also establishes the practical baseline for later evaluation, yet the baseline itself can be transformed by the intervention. This point is especially important where public announcement, eligibility criteria, monitoring systems, or anticipatory behavior begin before formal implementation. The relevant pre-intervention history should therefore include preparatory epistemic and institutional events when those events can influence later outcomes.

Caution 11.488 (Diagnostic closure). A diagnosis can become practically misleading when it is treated as a fixed description after the intervention, monitoring regime, or surrounding conditions have changed the field. Integrated design should preserve explicit triggers for reopening the diagnostic state.

Reopening triggers can include contradictory evidence, emergence of a previously unobserved affected position, failure of a key mechanism, a structural break, model drift, a change in institutional authority, a new legal or material constraint, or persistent divergence between observed and expected histories. Reopening diagnosis is therefore part of competent intervention design, not evidence that the initial inquiry was methodologically pointless.

11.27.2 Historical-Relational Subject Reconstruction

Historical-relational subject reconstruction identifies who or what occupies practically relevant positions within the evolving field. Section 11.7 developed the historical-relational decision subject as a subject represented through its event history, relations, capacities, classifications, and transformations. Integrated intervention design extends that idea from decision analysis to the complete intervention lifecycle.

Definition 11.489 (Integrated subject reconstruction). An *integrated subject reconstruction* is a versioned representation of a practically relevant subject or subject-position that links identity conditions, event history, relations, capacities, constraints, classifications, institutional locations, exposure to intervention, available responses, and transformation pathways to the decisions and evidence that depend on that representation.

The reconstruction can concern persons, households, organizations, communities, institutions, ecological actors, infrastructures, or other entities appropriate to the application domain. GR does not require that these objects share one ontological status. The methodological requirement is that their practical role be represented with enough historical and relational structure to avoid collapsing a trajectory into a static label when the trajectory matters for action.

Subject boundaries should remain explicit. A person can participate in several institutional and relational positions simultaneously. An organization can have internal subgroups with divergent capacities and exposures. A community can change composition during the intervention. A platform or administrative system can mediate the actions available to subjects and therefore function as part of the practical subject architecture. Integrated design should document which level of subject reconstruction supports each claim and decision.

Historical-relational reconstruction is especially important for intervention se-

quencing. Two subjects with similar current measurements can possess different prior event histories and therefore different capacities, obligations, trust relations, vulnerabilities, or responses to the same intervention. A prior classification can influence eligibility; a previous failed intervention can alter willingness to participate; accumulated institutional dependence can make nominally reversible change practically difficult. The intervention architecture should therefore avoid treating current-state equivalence as sufficient evidence of trajectory equivalence.

The subject reconstruction should also record intervention-generated transformation. Once a program changes a subject's recognized status, resource access, relationships, obligations, expectations, or institutional location, later decisions should use the transformed reconstruction. This avoids a common methodological error in which the initial target population remains conceptually fixed while the intervention itself changes the subjects and relations under study.

Proposition 11.490 (Subject-state continuity). *When an intervention materially transforms a subject's relations, capacities, classifications, or institutional position, subsequent decision and evaluation stages should reference an updated historical-relational reconstruction while retaining the pre-intervention subject state as historical provenance.*

Participation can contribute directly to subject reconstruction. Affected positions can identify relations, meanings, constraints, and historical events that are weakly visible to institutional data systems. Participatory evidence should therefore enter the reconstruction with its provenance preserved, alongside quantitative, historical, interpretive, administrative, or computational evidence. Integration does not require reduction of these forms to one scale of representation.

11.27.3 Situated Practical Orientation

Situated practical orientation links diagnosis to the evaluative frame through which commitment becomes intelligible. Section 11.3 treated goals and criteria as possible local articulations of historically formed orientations rather than universal inputs. Integrated design therefore records the orientations, protections, obligations, criteria, and comparison rules that materially organize the intervention together with their provenance and revision conditions.

Definition 11.491 (Orientation-integration record). *An orientation-integration record documents the practical orientations, any local goals or criteria, protected conditions, relevant values, affected positions, institutional authority, evidential basis, conflicts, comparison rules, uncertainty, and revision conditions that organize an intervention design at a specified stage of its history.*

Where explicit objectives are appropriate, an integrated design can distinguish terminal objectives from enabling objectives. A project can seek an ultimate improvement in some practical condition while pursuing intermediate capacities, infrastructures, relationships, knowledge, or institutional arrangements that make later improvement possible. Treating enabling objectives explicitly can prevent early evaluation from misclassifying a capacity-building stage as failure merely because the final outcome has not yet appeared.

Practical orientations and any associated goals can possess different temporal horizons. Immediate protective goals can coexist with medium-term relational goals and long-term generative goals. The architecture should record possible tension among

these horizons. An action that rapidly improves an immediate indicator can reduce later adaptability; a slower intervention can increase capacity while leaving short-term burdens insufficiently addressed. Integrated design can therefore use a temporally differentiated orientation architecture when the practical situation contains such tensions.

The evaluative frame should identify protected constraints and obligations separately from dimensions that can legitimately enter trade-off or optimization. Some conditions can function as side constraints on the action space; others can operate as evaluation criteria among feasible alternatives. This distinction should be visible before formal optimization or delegated recommendation because computational systems can otherwise treat a protected condition as merely another weighted term.

Practical orientations, goals, and criteria can change legitimately when the field changes, when affected positions contribute new information, or when intervention-generated evidence reveals an overlooked consequence. Revision should preserve the historical record of the previous goal state. This makes it possible to distinguish success under the original objective from success under a later revised objective and to identify whether a favorable evaluation results from genuine improvement or from retrospective movement of the criterion.

Definition 11.492 (Evaluative-frame reopening trigger). An *evaluative-frame reopening trigger* is a pre-specified or subsequently justified condition that initiates reconsideration of an intervention's orientations, goals, criteria, protected constraints, or comparison structure because the practical field, available evidence, affected positions, institutional mandate, or anticipated consequences have materially changed.

Revision of the evaluative frame can itself be an epistemic and political event. Changing what counts as success, protection, admissibility, or relevant value can redistribute attention, resources, recognition, and burden. Integrated design should therefore identify who has authority to revise the frame, who can contest the revision, and how changes propagate to monitoring indicators, decision criteria, models, and exit conditions.

11.27.4 Epistemic Events and Evidence Architecture

Evidence architecture connects the practical field to the representations used for action. Section 11.4 distinguished observation from epistemic events and showed that recognition, classification, communication, institutional uptake, and related processes can alter the field whose evolution they inform. Integrated design makes this distinction operational across the complete intervention cycle.

Definition 11.493 (Integrated evidence architecture). An *integrated evidence architecture* specifies the sources, observation channels, transformations, classifications, interpretive procedures, models, uncertainty representations, provenance records, update rules, access conditions, and performative-coupling pathways through which information enters and changes an intervention design.

The architecture should identify whether an evidential object is primarily descriptive, inferential, predictive, interpretive, participatory, model-generated, or intervention-generated. These categories can overlap, yet their differences matter for practical use. An administrative record can be strong evidence of an institutional classification while remaining weak evidence of the lived condition that the classification is intended to approximate. A model output can be useful for forecasting

while remaining dependent on assumptions whose practical validity is uncertain. A participant account can reveal mechanisms unavailable in aggregate data while requiring careful interpretation of scope.

Provenance should extend beyond source citation. For an operational intervention, relevant provenance can include when the evidence was produced, which version of an observation system generated it, how missingness was handled, which transformations were applied, which model or interpretive frame mediated it, who authorized its use, and which decisions subsequently relied on it. This is especially important when later evaluation asks whether an intervention failed because the mechanism was inadequate or because the evidence architecture systematically misrepresented the field.

Performative coupling requires a separate record. Publishing a risk classification can change behavior; communicating a forecast can influence expectations; introducing a monitoring system can alter reporting; an AI recommendation can become a coordination signal; eligibility criteria can change how subjects present themselves. These effects should enter the design as possible causal pathways within the intervention field.

Definition 11.494 (Epistemic-event ledger). An *epistemic-event ledger* records materially relevant acts of observation, classification, recognition, interpretation, communication, model output, institutional uptake, contestation, and revision together with their provenance, intended epistemic function, possible performative effects, and links to subsequent practical decisions.

The ledger can remain qualitative. Its purpose is historical traceability. Section 11.4 provides the conceptual distinction between epistemic content and practical uptake, while Section 11.12 provides optional operator, field, history, and transition representations when formalization is useful. Any formal representation should preserve the distinction between a computational object and the empirical or institutional process it represents.

Formal and machine-mediated observation or recommendation belong inside this epistemic architecture when their outputs materially affect action. Section 11.26 identifies boundary conditions concerning normative provenance, responsibility, human-relational distance, temporal transport, regime sensitivity, and performative feedback. Integrated design should record the model or rule version, source evidence, mediation chain, uncertainty, responsible roles, contest routes, and later uptake at a depth proportionate to practical consequence.

11.27.5 Generative History Space

Generative history construction links the reconstructed present to possible later developments. Sections 11.8 and 11.12 developed scenario families, alternative histories, formal models, history complexes, and history weights. Integrated design organizes these resources around the decisions and interventions that can change which histories remain accessible.

Definition 11.495 (Integrated generative history space). An *integrated generative history space* is a documented family of relevant possible histories generated from the current diagnostic, subject, relational, institutional, and evidential state, with explicit assumptions concerning transition conditions, action dependence, uncertainty, performative epistemic effects, and the criteria by which histories are compared or re-

vised.

A history space can be represented narratively, comparatively, through causal models, simulation, event graphs, partially ordered complexes, stochastic processes, dynamical systems, or combinations of these methods. Integrated design selects the representation according to the practical question. The architecture should resist conversion of methodological plurality into a single formal vocabulary when the conversion would discard relevant meaning or uncertainty.

The central object is the family of plausible or decision-relevant developments, not a claim that the future is fully enumerable. Some interventions are characterized by deep uncertainty in which important future states, mechanisms, or criteria remain partially unknown. In such cases, the history space should include unknown-region markers, stress scenarios, qualitative boundary cases, and conditions for expanding the action space when surprises arise.

History construction should include the intervention's epistemic effects. If publishing an evaluation changes participation, or if a model-mediated classification changes institutional treatment, then those epistemic events belong inside the possible histories. Similarly, observation can be endogenous to intervention because monitoring changes visibility, classification, and response. The history space therefore links practical and epistemic evolution.

The architecture should distinguish transition plausibility from value. A history can be plausible and undesirable; desirable and weakly supported; robustly acceptable across several models; or strongly dependent on one contested assumption. Keeping these dimensions distinct allows decision analysis to compare practical support without treating probability, preference, and legitimacy as interchangeable quantities.

Definition 11.496 (History-space revision trigger). A *history-space revision trigger* is an event or evidential condition indicating that the currently represented family of possible histories has become materially incomplete, misweighted, structurally mis-specified, or practically outdated for the decision at hand.

Examples include observation of a transition absent from the model, emergence of a new actor or constraint, failure of a central mechanism, a structural break, persistent residual error, reinterpretation of a historical analogy, successful contestation of a classification, or intervention-generated transformation of the subject population. Revision should preserve the previous history space and the event that motivated replacement or expansion.

11.27.6 Decision

Decision transforms reconstructed possibilities into practical commitment. Sections 11.7–11.14 developed action spaces, robustness, adaptive decision-making, optimization, formal and quantitative models, historical interpretation, and participatory methods. Integrated design coordinates these resources through an explicit decision dossier that connects the choice to the current versions of diagnosis, goals, evidence, subject reconstruction, and history space.

Definition 11.497 (Integrated decision dossier). An *integrated decision dossier* records the decision situation, admissible action space, goals and protected conditions, affected positions, relevant histories, comparison methods, uncertainties,

robustness and sensitivity results where applicable, participatory or institutional judgments, dissent, authorization, implementation conditions, monitoring obligations, revision triggers, and exit or rollback provisions associated with a practical commitment.

The action space should be treated as constructed. Institutional rules, material constraints, available knowledge, imagination, social legitimacy, technology, and prior decisions determine which actions are visible and feasible. A decision process that compares only currently recognized alternatives can therefore reproduce an artificially narrow possibility space. Integrated design should preserve mechanisms for action generation, including participatory proposals, redesign of institutional constraints, staged capability building, and machine-assisted exploration where appropriate.

Decision criteria should remain linked to their provenance. Robustness analysis can identify actions that perform acceptably across model or scenario uncertainty. Optimization can help when objectives, constraints, and relevant quantities are sufficiently specified. Historical and interpretive analysis can identify meanings or path dependencies unavailable to a compact numerical model. Participatory methods can reveal affected positions and legitimate criteria. An integrated decision does not require these methods to produce one common metric. It requires a documented relation among their contributions.

Decision authority should be distinguished from epistemic contribution. A model can supply a forecast; an affected group can supply experiential evidence; an expert can evaluate mechanism plausibility; an institution can hold legal authority; a deliberative body can establish a value-sensitive criterion. Collapsing these roles into a single hierarchy can conceal where practical responsibility actually lies. The dossier should therefore state who contributes what kind of judgment and who ultimately authorizes commitment.

Proposition 11.498 (Decision–design correspondence). *A practical commitment is more traceable when the selected action can be mapped to the current diagnostic state, subject reconstruction, goal-formation record, evidence architecture, history space, comparison procedure, and authorization process that jointly support it.*

Conditional decisions can be especially valuable under uncertainty. A staged decision can specify an initial action together with observation conditions and later branches. This converts part of the decision problem into a designed learning process. The value of such staging depends on whether the initial stage preserves meaningful future options and whether monitoring can generate information before irreversible commitments accumulate.

11.27.7 Intervention

Intervention is the realized modification of the practical field. Sections 11.15–11.20 developed target selection, timing, scale, depth, mechanism design, pilots, and experimental intervention. Integrated design binds these dimensions into a versioned implementation architecture whose realized form can be compared with the intervention that was authorized.

Definition 11.499 (Integrated implementation state). *An integrated implementation state records the intervention actually enacted at a specified stage, including targets, mechanisms, timing, sequence, scale, depth, responsible positions, resources,*

enabling conditions, constraints, protective measures, deviations from design, generated epistemic events, and the links between implementation actions and the decision dossier that authorized them.

The distinction between designed and realized intervention is essential. Implementation can diverge because resources arrive late, institutions adapt procedures, affected subjects respond unexpectedly, personnel exercise discretion, technical systems change, or external events alter feasibility. Evaluation should therefore compare outcomes with the intervention actually realized and preserve the original plan as a separate reference object.

Target, timing, scale, and depth should be recorded together because their interactions can determine practical effects. A mechanism that works at a pilot scale can encounter coordination constraints at larger scale. A shallow informational intervention can become a deep relational intervention if access to essential resources becomes conditional on compliance. A temporary classification can become historically durable if later institutions reuse it. Integrated design therefore evaluates intervention dimensions through their combined history.

Intervention can create new capacities as well as new constraints. An implementation stage can deliberately construct later action space by building knowledge, infrastructure, relationships, institutions, or participation channels. These generative effects should be recorded even when they are intermediate to the original outcome. Conversely, an intervention can consume reversibility reserves, narrow future options, or create dependencies. The implementation state should make both directions visible.

Protective measures belong inside intervention design. They can include staged exposure, bounded eligibility rules, independent review, opt-out routes, compensation reserves, alternative service pathways, data-minimization procedures, rollback capacity, or protection of groups bearing concentrated risk. Their adequacy should be evaluated under the same monitoring and revision architecture as the primary mechanism.

Caution 11.500 (Implementation identity). An intervention should not be treated as a stable treatment label when its mechanism, scale, target population, institutional environment, or observation regime has materially changed. Versioned implementation records preserve the distinction among substantively different intervention histories.

11.27.8 Monitoring and Performative Observation

Monitoring creates the principal recursive interface between implementation and revision. Sections 11.21 and 11.22 developed monitoring regimes, relational and generative indicators, observer effects, feedback architecture, and adaptive revision. Integrated design combines these elements by treating monitoring simultaneously as measurement, evidence production, and a possible intervention in its own right.

Definition 11.501 (Integrated monitoring state). An *integrated monitoring state* records the current observation architecture, indicators, source and transformation provenance, reporting cadence, responsible positions, uncertainty, intervention-generated evidence, observer and classification effects, warning conditions, feedback pathways, and the practical revisions that monitoring can trigger.

Indicator selection should follow from the complete intervention architecture. Immediate outcomes can show whether implementation occurred; relational indicators can show how interaction patterns change; capacity indicators can show whether subjects gain or lose practical ability; constraint indicators can reveal newly binding limitations; generative indicators can track changes in future option space; distributional indicators can identify concentrated burdens or benefits. A compact dashboard can be useful only when its compression remains connected to the richer evidence architecture behind it.

Monitoring frequency should match the dynamics and consequences of the intervention. High-frequency observation can be valuable where rapid failure requires immediate protection. It can also impose burden, generate noise, encourage short-horizon optimization, or intensify surveillance. Lower-frequency monitoring can miss rapid transitions. Integrated design therefore links cadence to the temporal structure of the mechanism and to the practical cost of observation.

Performative observation deserves explicit treatment. A published performance score can redirect organizational effort; risk monitoring can change behavior; repeated surveying can influence participants; algorithmic classification can alter access; visible thresholds can induce strategic adaptation. The monitoring state should therefore distinguish changes in the field from changes induced by the monitoring regime itself where the distinction is practically relevant.

Definition 11.502 (Monitoring-mediated intervention event). A *monitoring-mediated intervention event* occurs when an observation, indicator, classification, report, alert, or feedback communication generated by the monitoring system materially changes relations, behavior, institutional response, resource allocation, or subsequent observability within the intervention field.

Such events should be incorporated into the epistemic-event ledger and the generative history space. They can be beneficial, as when an early-warning signal activates protection, or harmful, as when a public classification stigmatizes a group. Their inclusion prevents the monitoring system from being treated as an external spectator when it participates in the practical dynamics.

Monitoring should also protect negative evidence. Absence of the expected effect, emergence of a contradictory case, and persistent disagreement among evidence sources can be more informative than smooth confirmation of the intervention theory. Integrated design should therefore preserve exception channels that prevent aggregation from erasing diagnostically important cases.

11.27.9 Evaluation

Evaluation interprets the evolving intervention history against goals, criteria, mechanisms, and affected positions. Section 11.23 developed immediate, relational, structural, capacity, constraint, option-space, historical, and generative forms of evaluation. Integrated design organizes these forms into a claim architecture that distinguishes what has been observed from what can be inferred and what remains open.

Definition 11.503 (Integrated evaluation state). An *integrated evaluation state* is a time-indexed set of evaluative claims linking realized implementation, observed outcomes, relational and structural changes, subject transformations, capacity and constraint effects, option-space changes, historical interpretation, uncertainty, affected-position evidence, and the goals and criteria against which those effects are assessed.

Evaluation should remain sensitive to delay. Some effects appear quickly while others require longer histories. A short-term improvement can coexist with a slower erosion of capacity; an intervention that initially increases burden can later generate durable access or coordination; structural effects can remain latent until a later shock reveals them. The evaluation state should therefore specify the temporal horizon of each claim.

Attribution should also be scoped. In complex intervention fields, several processes can contribute to the observed history. Evaluation can estimate causal contribution through experimental, quasi-experimental, comparative, process-tracing, formal, interpretive, or mixed methods where appropriate. The integrated architecture records the inferential basis and its limitations while permitting method choice to follow the local attribution problem.

Evaluation should compare the realized history with several reference objects. These can include the pre-intervention baseline, one or more counterhistories, the expected generative history family, alternative interventions, protected constraints, and trajectories of differently positioned subjects. Comparison against a single aggregate outcome can conceal whether an intervention improved one dimension while generating concentrated harm elsewhere.

Failure detection and repair developed in Section 11.24 enter evaluation through explicit criteria. The project should distinguish poor outcome, mechanism failure, implementation failure, observation failure, criterion failure, model failure, and distributional or ethical failure where these categories are analytically useful. The classification of failure determines which component should be revised.

Proposition 11.504 (Evaluation as revision input). *Within integrated intervention design, evaluation has a practical function when its claims are linked to explicit continuation, repair, model revision, action-space revision, rollback, compensation, or exit pathways appropriate to the type and severity of the finding.*

An evaluation can therefore generate several responses. It can confirm continuation under the current architecture; motivate parameter adjustment; reopen diagnosis; revise the subject reconstruction; change goals; replace a model; expand the action space; initiate repair or compensation; reduce scale or depth; or trigger exit. The appropriate response depends on the provenance and scope of the evaluative claim.

11.27.10 Model, Operator, and History-Weight Revision

Model revision updates the representations through which the intervention architecture anticipates and interprets practical evolution. Sections 11.4, 11.12, and 11.22 developed model plurality, practical operators, history complexes, history weights, sensitivity, model risk, and feedback-driven revision. Integrated design combines these elements by specifying which observations or epistemic events can revise which representational components.

Definition 11.505 (Integrated representation-revision record). An *integrated representation-revision record* documents a materially relevant change to a practical model, operator, transition rule, history family, history weight, parameterization, classification system, or interpretive frame together with the evidence, discrepancy, judgment, responsible position, validation procedure, and downstream decisions affected by that change.

A model revision can take several forms. Parameters can change while structure remains stable. Variables or relations can be added or removed. A transition mechanism can be replaced. A model can be restricted to a smaller validity region. Competing models can receive different practical weight. A qualitative historical interpretation can replace an inadequate quantitative representation for one part of the decision. An entire model family can be retired when the practical field moves beyond its assumptions.

Operator revision concerns representations of events that change the practical field. If a classification event has stronger effects than expected, its operator representation can be revised. If an institutional announcement changes behavior only under certain relational conditions, the operator can be conditioned accordingly. In applications where operator algebra is useful, order effects can be represented explicitly. The formal update remains a model of practical sequencing under the chapter's ontological-suspension commitment.

History-weight revision concerns the relative practical support assigned to alternative histories under the current evidence and model family. A new observation can increase support for one trajectory, reduce support for another, or reveal a previously omitted branch. Weight revision should preserve the model and evidence dependence of the weights. A numerical weight is meaningful only within the interpretation that generated it.

The architecture should distinguish learning from adaptive overfitting. Frequent revision can improve fit to recent observations while reducing stability, interpretability, or transfer. A project should therefore record revision thresholds, validation procedures, holdout evidence where appropriate, historical plausibility checks, and independent review for changes with large practical consequences.

Caution 11.506 (Revision-induced instability). A practical architecture can become difficult to evaluate when models, criteria, indicators, and implementation rules change faster than their consequences can be observed. Revision cadence should therefore reflect the temporal structure of the effects under study and the risks associated with delayed correction.

Machine-mediated and externally maintained models require the same discipline with additional version dependencies. A provider-side update, retrieval-corpus change, prompt or interface change, tool integration, or model substitution can alter outputs without an obvious change in the surrounding practical field. The boundary conditions in Section 11.26 therefore reinforce the need to link computational versions, responsible institutions, transport assumptions, and consequential uptake to the intervention-design state that relied on them.

11.27.11 Action-Space Revision

Action-space revision converts learning into new practical possibility. Sections 11.7 and 11.22 treated action spaces as evolving and developed pathways through which feedback can add, remove, suspend, sequence, or redesign actions. Integrated design places this process after evaluation and representation revision while allowing it to occur earlier when urgent evidence reveals that the current action set is unsafe or inadequate.

Definition 11.507 (Integrated action-space revision). An *integrated action-space revision* is a documented change to the set, structure, feasibility status, sequencing, au-

thorization conditions, or design parameters of practical actions available to the intervention process, grounded in revised diagnosis, evidence, goals, models, capacities, constraints, or institutional conditions.

Action-space expansion can arise through innovation, capability building, institutional redesign, new partnerships, additional resources, participatory proposal, technological development, or reinterpretation of constraints. Contraction can arise because an action proves harmful, loses legal authority, becomes infeasible, consumes a critical resource, or violates a protected condition. Temporary suspension can preserve an action for later re-evaluation while protecting subjects during uncertainty.

The architecture should distinguish feasible from authorized and desirable. An action can be technically feasible while institutionally unauthorized; legally available while ethically unacceptable under the project criteria; desirable while currently impossible because enabling capacities are absent. These distinctions help identify whether the appropriate intervention is direct implementation or construction of the conditions that make a later action possible.

Action-space revision can also change the decision question. Discovery of a new intervention mechanism can make previous comparisons obsolete. A failed pilot can reveal that the relevant choice concerns institutional redesign at a different analytical level from parameter adjustment. A successful protective measure can enable experimentation that was previously too risky. Integrated design therefore allows revised action spaces to reopen scenario construction, situated practical orientation, and diagnosis.

Definition 11.508 (Option-preservation profile). An *option-preservation profile* records which future actions remain accessible, become newly accessible, become more costly, require additional enabling conditions, or become practically foreclosed under a proposed action or action-space revision.

Option preservation is especially important under deep uncertainty. A policy can achieve a favorable immediate outcome while consuming institutional trust, fiscal capacity, ecological resilience, data rights, technical independence, or other resources needed for later adaptation. The action-space architecture should therefore represent future practical capacity alongside current performance where such effects are material.

Table 11.27 summarizes the principal stage objects and their most important reopening pathways. The table is a coordination aid with project-specific ordering; projects can combine stages or iterate among them at different temporal scales.

11.27.12 Exit

Exit closes one intervention phase while preserving the histories, obligations, and capacities generated by that phase. Section 11.25 distinguished exit, rollback, partial reversal, residual obligation, post-exit monitoring, discharge, and re-entry. Integrated design positions these elements inside the intervention architecture from the beginning of design.

Definition 11.509 (Integrated exit state). An *integrated exit state* records the reason and authority for exit or rollback, the implementation elements terminated or retained, reversibility and reversal remainders, subject and relational conditions at withdrawal, transferred responsibilities, residual obligations, compensation or re-

Table 11.27: Principal objects and reopening pathways in integrated intervention design.

Design noment	compo-	Principal documented ob- ject	Illustrative reopening conditions
Diagnosis		Integrated diagnostic state	Contradictory evidence, structural break, omitted affected position, mechanism failure, changed constraints
Situation map- ping	map-	Practical-epistemic situation profile	Changed observability, time pressure, uncertainty structure, regime condition, stakes, reversibility, power, or responsibility configuration
Subject recon- struction	recon-	Historical-relational subject reconstruction	New event history, reclassification, changed relation, institutional relocation, intervention-generated transformation
Practical orienta- tion	orienta-	Orientation and criterion record	Changed mandate, affected-position evidence, newly visible harm, transformed feasibility, value conflict, or revised candidate orientation
Methodological composition		Method-composition record	New evidence mode, model disagreement, revealed blind spot, changed decision horizon, failed transfer, or newly available method
Evidence archi- tecture	archi-	Evidence architecture and epistemic-event ledger	Observation-system change, contested classification, new source, performative effect, model-mediated error
History space		Generative history space	Unexpected transition, omitted branch, model failure, new actor, changed mechanism or history weight
Decision		Integrated decision dossier	Instability, new action, criterion change, authority change, deepened uncertainty, failed commitment condition
Intervention		Integrated implementation state	Implementation deviation, changed scale or depth, resource failure, new dependency, protection trigger
Monitoring		Integrated monitoring state	Indicator failure, observer effect, warning signal, data drift, burden, changed observability
Evaluation		Integrated evaluation state	Delayed consequence, distributional divergence, failure reclassification, new counterhistory, revised criterion
Representation revision		Representation-revision record	Persistent residuals, invalid assumption, model drift, new evidence, operator or sequencing mismatch
Action-space revi- sion		Action-space version and option-preservation profile	New capacity, new constraint, discovered mechanism, safety suspension, institutional redesign
Exit and rollback		Exit architecture and residual-obligation ledger	Exit condition, rollback trigger, irreversibility, residual harm, discharge condition, re-entry trigger

pair duties, post-exit monitoring, discharge criteria, preserved evidence, and re-entry conditions.

Exit can result from success, failure, external change, completion of a temporary mandate, replacement by another institution, exhaustion of resources, unacceptable risk, or transformation of the problem itself. These pathways have different implications for evaluation. Successful completion can leave maintenance obligations; failed intervention can require repair and compensation; institutional transfer can preserve the mechanism while changing responsibility; emergency termination can prioritize immediate protection while leaving unresolved evidence or implementation questions.

Rollback should be connected to the versioned implementation history. Reversal of the most recent operational change may leave earlier relational or institutional transformations intact. Data generated by a program can persist; subjects can retain changed expectations; new infrastructure can remain; classifications can continue to circulate; contracts or dependencies can outlive funding. The integrated exit state should therefore identify the practical remainder and treat cessation and restoration as separate conditions.

Residual obligations can extend beyond the organization that originally implemented the intervention. A handoff process should identify which institution, community, contractor, public body, or other position assumes ongoing duties. Where responsibility remains disputed, the dispute itself should be documented as part of the exit state because uncertainty over responsibility can become a source of later harm.

Post-exit monitoring should be proportionate to plausible delayed effects. Some interventions require only confirmation that withdrawal is complete. Others can require longer observation because delayed harms, dependency effects, institutional adaptation, or downstream benefits remain possible. The monitoring regime should specify when obligations can be discharged and what evidence is sufficient for discharge.

Re-entry should be treated as a new decision under historically altered conditions. A previous intervention changes the field, so re-entry should use an updated diagnosis, subject reconstruction, evidence architecture, and history space. The old intervention dossier can remain evidence, yet it should not automatically function as authorization for renewed action.

Proposition 11.510 (Recursive closure). *Exit completes an intervention phase methodologically when the withdrawal or rollback decision, residual obligations, post-exit observation, discharge conditions, and possible re-entry pathways are incorporated into the same provenance architecture that governed diagnosis, decision, implementation, and evaluation.*

Definition 11.511 (Integrated intervention dossier). *An integrated intervention dossier is the linked record through which the current and prior versions of diagnosis, subject reconstruction, goals, evidence architecture, history space, decision, implementation, monitoring, evaluation, representation revision, action-space revision, and exit conditions can be reconstructed together with their unresolved uncertainties, authorities, responsibilities, and cross-stage dependencies.*

The dossier need not be a single document. Depending on the practical setting, it can be distributed across qualitative case records, data systems, model repositories, meeting records, decision logs, legal instruments, monitoring dashboards, and archival materials. Integration concerns the ability to reconstruct materially relevant relations among these records. A project can therefore retain methodological plural-

ity while preserving a common practical lineage.

Several design invariants can help maintain this lineage across methodological variation. The intervention process should be able to identify which design version is currently authorized, which evidence and judgments support it, which uncertainties remain open, which positions possess decision and review responsibility, which observations can reopen commitment, and which exit or residual-obligation conditions remain active. These invariants describe coordination requirements; substantive answers remain project-specific. They can be implemented differently in a small community project, a public institution, a research intervention, or a computationally intensive decision system.

The depth of integration should remain proportionate to commitment. A bounded and readily reversible intervention can use a concise dossier and simple revision record. A large-scale, long-duration, institutionally deep, or difficult-to-reverse intervention can justify more extensive provenance, independent review, participatory records, model validation, protection architecture, and post-exit monitoring. Proportionality prevents integrated design from becoming documentation for its own sake while retaining stronger safeguards where the practical consequences of error are larger.

Proposition 11.512 (Proportionate integration). *The documentary and review burden of integrated intervention design should increase with the depth, duration, scale, uncertainty, dependence, distributional consequence, and irreversibility of the commitment, while preserving a traceable minimum architecture for diagnosis, authorization, monitoring, revision, and exit.*

11.27.13 Methodological Revision and Emergence

Integrated intervention design should preserve the possibility that the methodological architecture itself becomes inadequate. A field can generate an epistemic object that the existing monitoring system cannot represent, a new form of agency that changes responsibility, an institutional transformation that invalidates earlier categories, or a conflict among methods that cannot be resolved through the current composition. These conditions concern more than parameter updating. They can require revision of the methods through which the practical problem is framed and governed.

The situation map in Section 11.5 and the candidate orientations in Section 11.6 provide one way to make such revisions visible. A change from comparative stability to turbulence can shorten useful decision horizons. A newly recognized power asymmetry can make participation or independent review more important. A formal model can disclose sensitivity that motivates historical reconstruction; participant evidence can reveal a relation that requires a model boundary to change. The methodological repertoire can therefore co-evolve with the practical field.

Methodological emergence should not be romanticized. New methods can introduce opacity, instability, capture, administrative burden, or loss of comparability. A novel method can appear responsive while lacking validation. A rapidly revised procedure can make responsibility difficult to trace. Methodological innovation should therefore remain subject to the same demands of provenance, scope, evidence, responsibility, and evaluation that apply to other practical interventions.

Definition 11.513 (Method-composition record). *A method-composition record documents which methodological families are presently used for which practical func-*

tions, the reasons for their selection, their known limits and disagreements, the interfaces through which their outputs are combined, and the conditions under which the composition should be revised.

The record need not enforce a standardized mixed-method design. Its purpose is to prevent the composition from becoming invisible. A project can rely heavily on a formal model when its validity domain is strong, on historical or naturalistic judgment when contextual recognition is decisive, or on participatory processes when affected-position knowledge and value articulation are central. The composition remains justified by the local practical problem.

Proposition 11.514 (Open methodological integration). *Integrated intervention design remains compatible with GR's open research-programme status when the methods coordinated by the design are treated as a revisable repertoire rather than a completed procedural canon, and when materially consequential changes in that repertoire can themselves be documented, evaluated, and contested.*

Proposition 11.514 leaves a genuine research problem open. The present framework does not yet provide a complete theory for composing formal, interpretive, naturalistic, participatory, experimental, and other methods under simultaneous turbulence, deep uncertainty, high stakes, contested values, and changing power relations. Chapter 11 supplies provisional resources for that problem and treats their future revision as part of the research programme rather than as evidence of methodological failure.

Integrated intervention design therefore ends with a return to the conditions for future inquiry and action. The completed intervention history becomes part of the next diagnostic field; generated capacities and constraints become part of the next action space; classifications and institutional changes become part of later subject reconstruction; and unresolved consequences become evidence for future goals and obligations. The recursive architecture gives Chapter 11 a practical synthesis: application-dominant praxis can be organized as a historically traceable cycle in which knowledge and action co-evolve through versioned decisions, interventions, observations, and revisions. Section 310 uses this integrated architecture to specify the transition from domain-general GR methodology to economic praxis and to identify the additional objects that substantive GRE must introduce.

11.28 Economic Specification of Application-Dominant Praxis

The role of this section is to provide the minimal interface through which the domain-general methodology of Part IV can enter substantive Generative Relational Economics. Its objective is intentionally limited. The section does not predefine the economic subject, relation, resource, institution, value form, or economic field in detail, because those objects are developed systematically in Part V. It instead specifies what changes when the general objects of application-dominant praxis receive an economic interpretation and identifies the small set of domain questions required for a disciplined handoff. The discussion proceeds through domain specification, economic interpretation of general practical objects, economic representations and performative interfaces, and the transition to substantive GRE. The method is meta-level and boundary-preserving: economics is treated as one domain instantiation of

broader GR foundations, with explicit interfaces to neighboring disciplines and with substantive content left open to historical and empirical inquiry.

The preceding sections developed a methodology that can be used in many domains. Diagnosis can concern a legal institution, public-health system, educational environment, ecological field, technological infrastructure, or economic process. Historical-relational subjects, evolving action spaces, critical-transition uncertainty, monitoring, repair, and formal decision support therefore carry no exclusively economic meaning. Economic praxis begins when the practical field is specified in terms of economic relations and consequences at a resolution appropriate to the inquiry.

This transition should remain thin. If Chapter 11 were to supply a complete theory of economic subjects, institutions, resources, and value, Part V would repeat rather than develop the substantive programme. The present section therefore provides only a domain-specification interface.

Table 11.28 identifies questions rather than definitions. Each row can be answered differently in housing, labor, finance, care, knowledge production, ecological transition, public goods, platforms, development, international exchange, or another economic field. The common methodological inheritance supports comparison while the substantive ontology and empirical mechanisms remain open.

11.28.1 Domain Specification

Economic specification begins by delimiting why the practical field is being treated as economically relevant. The boundary can follow production, exchange, allocation, ownership, access, labor, consumption, finance, care, infrastructure, institutional provisioning, value conversion, resource dependence, or another economically significant relation. Several of these can coexist.

Definition 11.515 (Economic domain specification). An *economic domain specification* is a scoped and revisable statement identifying the economic relations, practical consequences, historical boundaries, scales, and interfaces that make a selected field relevant to GRE for the inquiry or intervention at hand.

The specification is analytical rather than jurisdictional. A household can be economically relevant without being reducible to market exchange. A legal category can be part of an economic field when it structures ownership or access. An ecological condition can enter economic analysis when production or allocation depends on it, while its ecological meaning remains irreducible to economics. The boundary therefore permits interdisciplinary interfaces without absorbing neighboring domains.

Domain specification also includes scale. A problem can be economic at the level of a household relation, organization, market, infrastructure, region, state, transnational network, or planetary resource system. The relevant level depends on the generative relations under study. Chapter 12 develops these scales through substantive economic architecture.

11.28.2 Economic Interpretation of General Practical Objects

The general objects developed in Parts II–IV acquire economic semantics only through a concrete field. A historical-relational subject can occupy positions as worker, owner, debtor, caregiver, consumer, taxpayer, investor, beneficiary, producer, platform par-

Table 11.28: Minimal interface between domain-general application-dominant praxis and substantive GRE.

Domain-general practical object	Economic specification question	Substantive destination in Part V
Subject / entity	Which economic positions, histories, capacities, and recognized entities are relevant to the inquiry?	Chapter 12: subjects, entities, positions, organizations
Relation / higher-order relation	Which relations organize access, production, exchange, obligation, dependency, coordination, ownership, care, knowledge, or authority?	Chapter 12: relational architecture
Resource / capacity / constraint	Which economically relevant resources, access relations, capacities, infrastructures, and constraints shape reachable action?	Chapters 12–13: resources, capacities, allocation
Practical orientation / evaluative frame	Which economic values, protections, distributions, obligations, and future possibilities matter for the intervention?	Chapters 13–14: allocation and generative value
Institution / rule / field	Which stabilized arrangements organize economic possibility and transformation?	Chapters 12 and 15: institutions, fields, multiscale history
Representation / epistemic event	Which prices, accounts, indicators, classifications, forecasts, scores, or models represent and potentially reshape economic relations?	Chapters 12–15 and Part VI: representation, value, power, knowledge
History / transition structure	Which event orderings, timescales, path dependencies, critical transitions, and generated possibilities matter?	Chapter 15: generative spacetime

ticipant, institution, household, or collective actor; but these labels do not exhaust the subject's relational history. A resource can be material, financial, informational, institutional, ecological, social, technical, or symbolic depending on how it conditions economic capacity and access. A relation can concern ownership, obligation, exchange, production, dependence, care, authority, credit, recognition, or coordination.

The methodological point is that economic specification selects which of these relations matter for the practical question while retaining the wider historical-relational subject when omitted relations could change the analysis. GRE therefore resists a fixed list of economic primitives at this transition stage. The substantive chapters can

stabilize concepts where the argument and evidence justify them.

Definition 11.516 (Minimal economic specification). A *minimal economic specification* identifies, at a resolution appropriate to the inquiry, the economic positions, relations, resources or capacities, institutions, value-relevant interfaces, representations, historical conditions, and practical scales required to interpret the general methodology of application-dominant praxis within the selected economic field.

Minimal specification is deliberately thinner than a full model. It can be expressed through prose, institutional mapping, formal representation, empirical variables, historical reconstruction, or mixed methods. Its adequacy depends on whether the selected objects preserve the economic relations necessary for the decision or research question.

11.28.3 Economic Representations and Performative Interfaces

Economic fields are unusually rich in consequential representations. Prices, accounts, budgets, classifications, ratings, forecasts, indices, contracts, valuations, scores, models, and public announcements can describe economic relations and can also contribute to changing them. Chapter 5 developed the general epistemology of performative representation, and Sections 11.4 and 11.26 developed the practical conditions under which epistemic uptake and formal decision systems become part of intervention history.

Economic specification therefore asks which representations enter the field, how they acquire authority, who can contest them, and through which relations their uptake changes access, expectation, allocation, investment, obligation, or institutional response. The substantive analysis can then determine whether a representation is merely descriptive, practically performative, or both at different stages.

Representation also provides one interface to value. A valuation can make heterogeneous objects comparable within a particular practice. An accounting rule can determine what enters an institutional decision. A price can coordinate exchange while leaving other value forms outside the transaction. GRE later examines heterogeneous value, conversion, circulation, return, capture, dissipation, and regeneration. Chapter 11 requires only that the practical use of economic representations preserve their provenance and possible performative effects.

Machine-mediated representations fit the same interface. A learned forecast, classification, or recommendation can be economically consequential through its institutional uptake. Its technical properties can matter greatly, while the domain-general boundary conditions of normative provenance, responsibility, human-relational distance, temporal transport, regime sensitivity, and reflexivity remain relevant regardless of whether the representation was generated by AI or by another formal system.

11.28.4 Handoff to Substantive GRE

The transition to Part V can now be stated compactly. Application-dominant GR provides a meta-methodological repertoire for situated orientation, practical diagnosis, evidence-to-commitment translation, evolving action spaces, scenario construction, robustness, adaptation, critical-transition uncertainty, formal and interpretive analysis, participation, intervention composition, monitoring, repair, exit, and recursive

revision. Economic specification assigns these methods to economic objects whose substantive content must be reconstructed historically and empirically.

Chapter 12 develops the *Relational Architecture of Economic Systems*. It specifies how economic subjects, entities, relations, organizations, institutions, markets, households, commons, platforms, infrastructures, resources, capacities, access, ownership, transfer, labor, coordination, dependency, asymmetry, symbolic relations, topology, fields, multiscale history, and generative potential can be represented within GRE. These objects are therefore introduced there in substantive form rather than anticipated exhaustively here.

Chapter 13 develops *Allocation as Relational Intervention*. The general intervention architecture of Part IV reappears with explicitly economic semantics: allocation changes access, capacities, constraints, obligations, dependencies, and future action spaces. Chapter 14 develops *Generative Value*, including heterogeneous value, conversion, circulation, transmission, return, capture, dissipation, regeneration, and justice. Chapter 15 develops *Generative Spacetime*, where event ordering, timescales, path dependence, fields, attractors, transition structure, and other locally justified representations receive economic interpretation.

The handoff preserves two boundaries. First, economic specification does not convert every relational phenomenon into economics. Neighboring legal, political, educational, ecological, historical, cultural, and technological processes retain their own analytical standing even when they interact with economic relations. Second, the general methodology does not predetermine one substantive economic ontology. Part V remains responsible for constructing, testing, and revising the economic objects required by GRE.

Chapter 11 therefore closes at the interface between method and domain. Its outcome is a configurable architecture for consequential praxis whose evaluative frames, epistemic conditions, formal models, intervention dimensions, responsibility relations, and reopening rules remain historically situated. Section 311 begins the substantive economic programme by specifying the economic domain at a level appropriate to the relational architecture developed in Chapter 12.

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Chapter 12

Relational Architecture of Economic Systems

Chapter 12 develops the foundational economic architecture required for substantive Generative Relational Economics (GRE). Its role is to specify the principal analytical objects through which economic systems can be studied relationally and historically before later chapters examine allocation, value, generative spacetime, power, epistemic economy, artificial intelligence, and domain-specific applications. The chapter's objective is therefore architectural rather than exhaustive: it establishes a revisable vocabulary for economic subjects, entities, events, relations, properties, states, processes, institutions, resources, capacities, access conditions, ownership, transfer, participation, dependence, asymmetry, symbolic representation, topology, history, and generative potential. The discussion proceeds by progressively widening the analytical resolution while repeatedly returning to the same methodological discipline: an economic object should be specified through the relations, histories, mechanisms, scales, and evidential conditions that make it relevant to the inquiry. The method is conceptual, historical, relational, and selectively formal. Mathematical or field-like representations are used only where they add analytical content, and the chapter maintains ontological suspension throughout.

Throughout this chapter, the phrase *economic systems* is used in a broad and scale-relative sense. It does not refer only to national economies, market economies, or regime types such as capitalism or socialism. It denotes a historically situated economic configuration that is treated as a system because selected economic entities, relations, events, properties, states, processes, structures, constraints, and differences are sufficiently coupled for their joint organization to matter to the inquiry. Such a system can be reconstructed at household, organizational, institutional, market, infrastructural, regional, national, transnational, or cross-scale levels. The word *system* therefore indicates organized interdependence rather than closure, equilibrium, self-sufficiency, or commitment to one mathematical systems representation. Its boundary remains an empirical and analytical attribution that can be revised when another delineation better captures the relevant mechanisms and histories.

The chapter begins from the proposition that the economic domain is neither a timeless substance nor a residual category defined only after politics, law, culture, ecology, and technology have been separated away. Economic specificity is treated

as historically and problem-relatively constructed. Scarcity, allocation, production, ownership, exchange, care, knowledge, finance, infrastructure, institutional access, and livelihood can each become economically salient under different questions. The task is not to settle a universal boundary around “the economy” but to state why a relation, entity, resource, institution, or process enters the economic frame and what mechanism makes that specification useful.

This approach requires a distinction between economic reality and its manifestations. Prices, accounts, contracts, classifications, legal titles, employment statuses, organizational charts, and statistical indicators can be causally consequential and can partly constitute economic positions, yet they do not necessarily exhaust the relational configurations that sustain those positions. Conversely, economically significant relations can precede or exceed their formal recognition. The chapter therefore separates relational reality, manifest representation, and institutional recognition while allowing them to interact recursively.

The chapter’s internal organization is anchored in the domain-general GR ontology developed earlier in the book. Section 12.3 makes that architecture explicit by relating the preliminary coordinates of constraint, change, structure, and difference to the emergent object forms of entity, event, relation, property, state, and process. The correspondence is many-to-many: later economic concepts such as markets, organizations, labor, ownership, or allocation can combine several ontological forms, while one ontological form can be instantiated through many economic objects. The map is used to orient the chapter and identify conceptual gaps rather than to impose a closed classification on economic reality.

Economic subjects and entities are treated as heterogeneous analytical objects. Persons, households, organizations, communities, public authorities, artificial systems, and non-human participants can occupy economically consequential positions, but comparability along one dimension does not imply equivalence along others. Subjecthood, agency, responsibility, welfare, recognition, participation, and historical continuity remain distinct questions. Economic entities are likewise represented as stabilized configurations whose boundaries, persistence, and identity can vary across legal, organizational, accounting, technical, functional, and relational dimensions. Stabilization means sufficient trackability for a stated purpose, not immobility or metaphysical permanence.

Relations constitute the central connective vocabulary of the chapter. Exchange, production, labor, ownership, credit, care, knowledge, trust, authority, dependence, cooperation, and conflict are treated as heterogeneous relation-forms that can overlap within the same empirical connection. Higher-order relations become relevant where configurations of several relations or participants contribute explanatory content that would be lost under adequate pairwise decomposition. Relational configurations then provide an intermediate analytical level between individual ties and larger structures such as organizations, institutions, markets, communities, platforms, and infrastructures.

Boundaries and membership are treated as economically consequential rather than merely classificatory. Legal, organizational, institutional, market, community, functional, access, exposure, and permeability boundaries can diverge. Formal membership can differ from effective participation, access, entitlement, obligation, representation, control, exposure, or practical ability to exit. Internal and external relations are therefore boundary-relative: the same relation can be internal to

one configuration and external to another without contradiction. This boundary discipline becomes especially important when analyzing organizations, institutions, markets, households, commons, platforms, and infrastructures, whose practical edges frequently differ from their formal ones.

Organizations are represented as relational condensations: comparatively stabilized concentrations of membership, roles, authority, coordination routines, resources, memory, and external interfaces that make selected collective capacities reproducible through time. Institutions are represented as relational infrastructures spanning formal and informal rules, norms, classifications, expectations, legal structures, administrative procedures, memory, and enforcement. Markets are treated as relational fields in which exchange and price coordination interact with participation conditions, information, expectations, cooperation, competition, intermediation, and historically constructed boundaries. Households, communities, and commons are analyzed without collapsing them into a single non-market category, while platforms and infrastructures are distinguished according to their mediating, access-organizing, standard-setting, and dependency-generating roles.

The chapter then develops the economic conditions through which action becomes possible. Resources are treated as relation-dependent and capacity-relative rather than as self-identifying stocks. Material, financial, temporal, spatial, informational, knowledge, attentional, infrastructural, institutional-access, and relational resources can differ in accessibility, durability, convertibility, and dependence on complementary conditions. Capacities concern what subjects or configurations can effectively do under specified conditions; constraints concern the conditions that restrict, shape, or channel those capacities. Resources, capacities, and constraints therefore remain analytically distinct, and they can co-evolve through action and institutional change.

Economic access adds another layer. Availability, formal eligibility, practical usability, continuity, timing, cost, mediation, and influence can diverge. Ownership and control are similarly decomposed into legal title, possession, use, exclusion, transfer, shared claims, rule-setting, and effective control. Transfer and circulation then describe changes in claims, possession, use, obligations, information, value, and control positions across time without assuming a conserved scalar moving unchanged through the system. Labor and participation broaden the account of economic contribution beyond formal employment, including paid and unpaid work, care, knowledge-intensive activity, automated participation, representation, exposure, and contribution outside employment relations.

Coordination and dependence describe how differentiated activities become mutually compatible and how capacities rely on resources, actions, knowledge, infrastructures, or permissions located elsewhere. Hierarchical, market, network, cooperative, and algorithmic coordination can each coexist with mutual or asymmetric dependence. Economic asymmetry is subsequently treated as dimension-specific difference in resources, capabilities, information, epistemic position, relational position, institutional standing, temporal position, or related conditions. Asymmetry can convert across dimensions and persist through identifiable mechanisms, yet asymmetry alone does not establish a normative verdict or a complete theory of power.

Economic life is also symbolized. Legal categories, administrative classifications, accounting systems, statistics, contracts, prices, credit representations, ratings, scores, and digital records make relations visible, comparable, actionable, and sometimes self-transforming. Representations can contain observational, categorical, temporal,

scale, or functional mismatch; they can also become performative when identifiable uptake mechanisms connect them to subsequent changes in expectations, access, classification, or action. Economic representation is therefore treated both as an episodic interface and, under some conditions, as part of the economic architecture itself.

Topology, scale, and history provide additional representational dimensions. Network connectivity, centrality, clustering, bridging, bottlenecks, peripheral positions, and field-like variation can illuminate patterned connection where those representations add explanatory content. Their use does not imply that economic reality is ultimately a network or field. Scale is treated as problem-relative rather than as a fixed micro–meso–macro ontology, and cross-scale claims require explicit mechanisms of transmission, aggregation, mediation, or feedback. Historical architecture develops through formation, stabilization, reproduction, crisis, reorganization, dissolution, path dependence, and emergence; continuity and change can coexist along different dimensions.

These architectural elements culminate in the concept of generative potential. An economic architecture can make later relations, capabilities, knowledge states, participation forms, options, constraints, dependencies, and transitions more or less accessible without determining which future will be realized. Generative potential is neither a scalar synonym for welfare nor a probability by default. It can be differentiated across positions, self-reinforcing, fragile, and historically reweighted. Greater generative potential is not automatically normatively preferable because economic architectures can generate exclusion, dependency, vulnerability, concentration, or foreclosure alongside knowledge, capability, cooperation, and expanded options.

The final architectural problem concerns the interface with allocation. Allocation can require information about conversion conditions, relations, higher-order structures, asymmetries, scales, and later possibilities, yet a theory of allocation belongs to the following chapter. Section 12.28 therefore closes Chapter 12 by stating which architectural distinctions later allocation analysis may need to inherit while keeping recipient-centered representations available where additional relational dimensions are immaterial. This preserves a general GRE commitment that recurs throughout the chapter: analytical complexity should be added when it changes explanation, interpretation, or practical judgment, not merely because a richer vocabulary is available.

The architecture developed here is intentionally open. The chapter does not claim to enumerate every economically relevant subject, relation, resource, institution, or generative mechanism. New technologies, ecological conditions, legal forms, social practices, and forms of agency may require additional concepts or revisions to those developed here. Nor does the chapter assign universal normative priority to persistence, generativity, decentralization, participation, access, symmetry, sustainability, or any other recurring consideration. These properties become objects of evaluation only after their subjects, histories, consequences, scales, and normative commitments have been specified.

This open status also constrains formalization. Networks, fields, event complexes, dynamical models, operator representations, optimization problems, simulations, and statistical models can provide consistent and operational languages for selected economic questions. Their usefulness depends on the adequacy of their objects, assumptions, evidence, and scope. Historical, interpretive, naturalistic, participatory, and institutional approaches can disclose dimensions that formal models compress

or leave implicit, while those approaches have their own limits of operationalization, verification, transportability, or comparability. GRE therefore treats methodological composition as problem-relative and revisable rather than prescribing one universal representational language.

Taken together, the chapter provides an economic object architecture rather than a closed economic ontology. Its purpose is to make visible the relations through which economic entities acquire practical meaning, the conditions through which resources become capacities, the structures through which access and control are organized, the histories through which configurations persist or transform, and the generative consequences through which present arrangements condition later possibilities. This architecture supplies the descriptive and analytical substrate on which later GRE work can formulate more specific theories of allocation, value, economic spacetime, power, knowledge, artificial intelligence, and economic organization without assuming that any one of those domains exhausts the economic world.

12.1 Economic Specificity and Domain Boundaries

The role of this section is to open Part V by moving from the domain-general foundations of Generative Relational Theory (GR) back into the substantive economic programme of Generative Relational Economics (GRE). Its objective is to specify what it means for a relational-generative inquiry to become economic without assuming that the economic domain has a timeless, self-evident boundary or that general GR concepts acquire economic meaning automatically. The discussion proceeds through seven steps: GRE as an economic specification of GR praxis, the historical and problem-relative character of economic specificity, the selection of economic objects, the interpretation of economic relations and configurations, the role of constraints and capacities, the scope conditions governing cross-domain translation, and the standing of GRE as a domain instantiation of a broader research programme. The method is reconstructive and programmatic. It draws on the disciplinary constitution established in Chapter 3, the domain-general epistemology and methodologies of Parts II–IV, and several established traditions that delimit economics in different ways, while treating the substantive architecture developed in this chapter as provisional and revisable.

The transition requires some care because the word *economic* already carries several intellectual histories. Scarcity and alternative uses have provided one influential delimitation of economic inquiry (Robbins 1932). Historical and institutional traditions have emphasized the changing organization of livelihood, exchange, property, and markets (Polanyi 1944; North 1990; Ostrom 1990). Relational sociology has shown that economic action can depend materially on ongoing social relations rather than on atomized actors alone (Granovetter 1985). Work on ethics and economics has questioned attempts to isolate economic evaluation from broader questions of agency, welfare, and value (Sen 1987). Historical analysis has also shown that the modern “economy” itself became stabilized as a particular object of representation and governance rather than simply appearing as an unchanged object across periods (Mitchell 1998). GRE enters this plural field as a further research programme, not as a replacement definition capable of settling the disciplinary boundary once and for all.

Table 12.1 summarizes the dimensions through which the present chapter begins

Table 12.1: Illustrative dimensions for specifying an economic field in GRE. The dimensions identify recurrent questions while leaving their substantive answers open to historical and empirical inquiry.

Dimension	Specification question	Scope discipline
Practical relevance	Which production, allocation, access, exchange, provisioning, labor, ownership, care, finance, or related processes make the field economically consequential?	Economic relevance is stated for the inquiry at hand rather than presumed from a fixed list of activities.
Subjects and positions	Which persons, households, organizations, communities, authorities, artificial systems, or other participants occupy economically consequential positions?	Economic positions do not exhaust the histories or identities of the participants that occupy them.
Relations	Which relations organize capacities, obligations, resources, expectations, dependencies, coordination, or transfers?	A relation can simultaneously have legal, political, cultural, ecological, or technological significance.
Resources and capacities	Which material, financial, informational, institutional, ecological, technical, social, or symbolic conditions affect what participants can do?	Resource status and economic salience depend on the relational and historical configuration.
Institutions and representations	Which rules, organizations, prices, accounts, classifications, contracts, metrics, or models stabilize and mediate economic interaction?	Representation can describe a field and can also participate in changing it.
History and scale	Which event histories, temporal horizons, scales, path dependencies, and transition processes affect the economic configuration?	Economic conclusions are qualified by the historical and scalar range over which they are supported.
Normative and disciplinary interfaces	Which value conflicts, responsibilities, power relations, legal rules, political authorities, ecological conditions, or cultural meanings materially affect the economic problem?	GRE preserves interfaces with neighboring domains rather than converting their distinctive questions into economics by default.

to specify an economic field. The table is a guide to inquiry rather than a checklist. Different empirical problems can require different resolutions, and some dimensions may remain outside the foreground of a particular study.

12.1.1 GRE as an Economic Specification of GR Praxis

Parts II–IV constructed a domain-general account of relational reality, epistemic access, research praxis, and application-dominant praxis. Those foundations provide GRE with a language for studying historical-relational subjects, epistemic events, partially ordered histories, changing constraints, performative representations, decision under incomplete knowledge, and interventions that alter later possibilities. Economic analysis begins when those general resources are specified through economically consequential objects and relations.

The term *specification* is important. It does not mean that a general GR model is first completed and then mechanically populated with economic variables. Economic inquiry can modify the meaning, resolution, and usefulness of the general categories themselves. A relation relevant to contract enforcement may need a different representation from a relation relevant to household care. A historical-relational subject represented adequately for a labor-market question may require additional institutional, familial, migratory, legal, or technical history for another economic problem. An intervention architecture suitable for a reversible pricing experiment can be inadequate for an infrastructural investment with long-lived dependencies. Economic specificity therefore emerges through reciprocal adjustment between the general framework and the domain being studied.

Chapter 3 already established GRE as an emerging economic research programme and distinguished it from broader GR. The present section does not reopen that disciplinary constitution. It gives the distinction substantive force. GRE assumes responsibility for economic explanation, evidence, mechanism, and interpretation. General GR supplies transferable questions and representations, while the economic domain determines whether those resources are adequate to production, allocation, circulation, provisioning, exchange, capability, ownership, labor, value, dependence, institutional organization, and the transformation of future economic possibility.

This relation is asymmetric in neither direction. General GR does not function as a doctrinal authority whose concepts economic cases are expected to confirm. Economic inquiry can reveal that a general distinction is too coarse, that a proposed representation omits an economically consequential mechanism, or that a category behaves differently once embedded in institutions such as property, credit, taxation, labor organization, accounting, or market exchange. Such findings can remain local to GRE, or they can later motivate revision of the wider GR programme. Domain instantiation is therefore also a potential source of theoretical correction.

A GRE study consequently need not deploy every concept introduced in the preceding Parts. The relevant methodological and conceptual resources depend on the research problem. Some inquiries may be adequately handled through institutional history and comparative evidence. Others may benefit from network, dynamical, statistical, computational, or field representations. Some may require participatory or interpretive access because economically consequential relations are mediated through meanings, classifications, expectations, or tacit practices. The economic programme inherits methodological pluralism together with the obligation to justify the local adequacy of the selected methods.

12.1.2 Historical and Problem-Relative Economic Specificity

Economic specificity concerns the conditions under which a phenomenon is treated as economically relevant for a particular inquiry. The present framework does not seek a single necessary-and-sufficient definition that would permanently separate economic from non-economic reality. The history of economic thought already provides several influential delimitations, and empirical economic life repeatedly crosses the conceptual boundaries associated with any one of them. Scarcity, market exchange, production, livelihood, institutions, welfare, ownership, labor, finance, household provisioning, public goods, care, knowledge, infrastructure, and ecological dependence can each become central under different theoretical and historical

conditions.

The diversity matters because a boundary of inquiry changes what becomes visible. A scarcity-centered analysis can clarify trade-offs among means with alternative uses (Robbins 1932). An institutional analysis can reveal how rules and enforcement structures organize incentives and uncertainty (North 1990). Analysis of commons can disclose governance arrangements that are difficult to understand through a simple market–state contrast (Ostrom 1990). Embeddedness analysis can show how supposedly economic transactions depend on relational structures (Granovetter 1985). Ethical and capability-oriented analysis can expose evaluative information that disappears when welfare is compressed into one behavioral or monetary representation (Sen 1987). These approaches need not be made equivalent for GRE to learn from the different aspects of economic specificity they disclose.

GRE therefore adopts a problem-relative boundary with explicit historical and disciplinary qualifications. A phenomenon becomes economically salient within an inquiry when its relations, constraints, capacities, transfers, institutions, or consequences materially enter the production, allocation, access, use, circulation, maintenance, conversion, or foreclosure of resources and possibilities that the inquiry has reason to treat as economic. The formulation is intentionally broad and remains a working orientation rather than a final definition. Its adequacy depends on whether it helps identify the mechanisms and consequences relevant to the problem without absorbing neighboring domains whose own concepts are doing indispensable explanatory work.

The boundary can change during inquiry. A project initially framed as a labor-market study may discover that immigration status, caregiving obligations, platform governance, housing access, or educational credentialing materially determines the observed employment relation. An analysis of credit may require the legal architecture of collateral and insolvency. A study of infrastructure may require ecological processes that constrain maintenance and future use. A study of automated allocation may encounter classifications whose political or legal authority determines economic access. Such discoveries can justify enlarging the economic specification, establishing an interdisciplinary interface, or returning part of the problem to another domain.

This openness does not imply that every social relation is economic. Unlimited scope would deprive the economic designation of analytical function and would obscure the expertise required by other domains. GRE therefore treats boundary choice as accountable. A study should be able to explain why a relation enters the economic analysis, which consequences make it relevant, what remains outside the economic frame, and where claims require support from law, political science, sociology, history, ecology, engineering, education, ethics, or another field.

Economic specificity is also historically revisable. The categories through which economies are represented can become more or less salient as material technologies, institutions, forms of property, infrastructures, productive forces, and systems of measurement change. Mitchell's historical account of the modern economy as an object of representation is especially relevant here because it cautions against assuming that contemporary macroeconomic boundaries simply reproduce a timeless economic object (Mitchell 1998). GRE extends this caution to its own vocabulary. Categories that currently organize analysis may require revision if new economic relations, agents, infrastructures, or forms of value become consequential.

12.1.3 Economic Objects and Analytical Selection

The substantive economic programme requires objects of analysis, but object selection does not by itself settle their ontological standing. Within GRE, an economic object can be a person occupying an economic position, a household, firm, public authority, community, asset, account, contract, organization, market, infrastructure, classification, resource, platform, currency, or another configuration that is sufficiently stabilized for the local inquiry. Later sections examine how such entities can emerge, persist, transform, and dissolve. The present subsection establishes only the discipline governing their selection.

An economic object is selected at a resolution. A worker can be represented as a labor supplier in one model, as a historically situated subject with skills, obligations, bargaining relations, migration history, and household dependencies in another, or as part of a collective organizational configuration in a third. Each representation can be useful. The question is whether the abstraction preserves the relations required by the claim being made. A representation adequate to estimate a wage response can be inadequate to explain why workers have unequal capacity to refuse the same contract.

Objects also depend on institutional recognition. Property, debt, employment status, organizational membership, account ownership, professional qualification, legal personhood, and eligibility for benefits are not merely descriptive labels attached to pre-given economic entities. Institutional recognition can stabilize positions, authorize actions, create obligations, and change access to resources. Economic analysis must therefore distinguish the physical or social configuration being studied from the institutional and representational processes through which that configuration becomes legible and actionable.

The same caution applies to aggregates. “The household,” “the firm,” “the market,” or “the state” can be analytically useful units while containing internal relations that materially affect the phenomenon under study. Aggregation can hide unequal control, differentiated responsibilities, internal transfers, unrecognized labor, or conflicting interests. Chapter 12 later develops internal and external relations precisely because the adequacy of an aggregate depends partly on what happens inside its apparent boundary.

Analytical selection also concerns absence. Some economically consequential objects remain weakly represented in formal records: informal work, unpaid care, ecological conditions, tacit knowledge, community-maintained infrastructures, or unregistered forms of mutual support can be central to actual provisioning while appearing marginal in official accounts. GRE does not infer importance from measurement alone. Observability is one epistemic property of an object, and institutional visibility can itself be an object of explanation.

Remark 12.1 (Object selection as a revisable commitment). Within the present framework, selecting an economic object commits an inquiry to a particular analytical resolution. The commitment remains revisable when omitted internal structure, external relation, historical trajectory, or institutional recognition materially changes the explanatory or practical question.

Remark 12.1 connects substantive economic architecture to the epistemic discipline developed in Part III. Reconstructing an object is already a methodological decision. Chapter 12 therefore treats objects and relations together rather than assuming

that relations merely connect entities whose identity has already been settled.

12.1.4 Economic Relations and Relational Configurations

Relations provide the central analytical orientation of Chapter 12. Economic life is organized through exchanges, production arrangements, labor relations, property claims, credit, care, knowledge, trust, authority, dependency, cooperation, conflict, transfers, memberships, and forms of coordination that can persist beyond any one transaction. These relations can be dyadic, collective, institutional, multilateral, nested, or mediated through infrastructures and representations. Their economic significance depends on what they enable, constrain, transfer, stabilize, or transform within the selected field.

A relational orientation does not imply that entities lack practical reality. Firms sign contracts, households hold assets, banks extend credit, public authorities levy taxes, and individuals make decisions. GRE asks additionally how these actors acquire and reproduce the capacities through which those actions become possible, how their positions depend on relations to others, and how the actions modify the relational field that later actors inherit. The analytical gain comes from holding entity-level and relation-level descriptions together rather than replacing one with the other.

Granovetter's account of embedded economic action provides one established demonstration that ongoing social relations can be economically consequential and that atomized descriptions can omit mechanisms relevant to actual transactions (Granovetter 1985). GRE takes a broader generative question: which later capacities, dependencies, institutions, expectations, and pathways are produced or foreclosed through the relation? The extension is a programmatic proposal rather than an attribution to embeddedness theory itself.

Relations can also change category as institutions and histories evolve. A cooperative exchange can become a dependency when alternatives disappear. Credit can provide productive capacity and later become a mechanism of constraint. A platform can coordinate previously fragmented participants and simultaneously reorganize access to customers, data, reputation, and payment. Care can sustain labor capacity while remaining weakly represented in market accounts. Ownership can authorize investment while also structuring exclusion. The relational category is therefore insufficient by itself; analysis must reconstruct the configuration, the distribution of positions within it, and the historical processes through which its consequences develop.

Higher-order relations are especially important. A transaction can depend on a banking system, payment infrastructure, legal regime, professional standard, information network, public guarantee, or social convention that is not reducible to the two apparent counterparties. Organizations can coordinate relations internally while mediating them externally. Markets can stabilize recurring expectations and rules among many participants. Commons can organize collective access and responsibility through institutional arrangements that differ from both individualized ownership and centralized administration (Ostrom 1990). Later sections develop these configurations in detail.

The economic relation also provides one bridge to value. A relation can transmit or convert resources and capacities, create or destroy options, change bargaining po-

sitions, generate knowledge, reorganize recognition, or alter later productive possibility. Chapter 14 will examine heterogeneous value and value transmission directly. Chapter 12 prepares that analysis by identifying the relational architecture through which such transformations occur.

12.1.5 Economic Constraints, Capacities, and Institutional Conditions

Economic architecture is shaped by both constraints and capacities. A constraint limits feasible action under specified conditions; a capacity supports the ability of a subject or configuration to act, produce, coordinate, learn, convert resources, maintain relations, or enter future possibilities. The same institutional arrangement can function differently across positions. Credit requirements can discipline lending while excluding actors without recognized collateral. Property rules can stabilize investment while restricting access. Technical standards can enable interoperability while raising entry costs. Infrastructure can enlarge mobility for some participants while creating new dependencies for others.

The distinction is relational because neither capacity nor constraint can always be located inside one actor. A worker's bargaining capacity depends partly on alternatives, collective organization, legal protections, household obligations, labor demand, information, and mobility. A firm's productive capacity can depend on suppliers, credit, infrastructure, public institutions, standards, knowledge, and workforce organization. A community's capacity to govern a shared resource can depend on institutional arrangements and histories of cooperation that are invisible if resources are represented only as physical stocks (Ostrom 1990). Economic possibility is consequently distributed across configurations.

Institutional economics provides established resources for analyzing how rules and organizations structure incentives, uncertainty, and economic performance (North 1990). GRE draws from this concern while keeping a wider field of possible consequences in view. Institutions can structure incentives, but they can also constitute categories, authorize positions, define ownership, create channels of recognition, establish evidentiary standards, allocate decision rights, and shape which future transformations remain available. These effects need not be captured adequately by incentive language alone in every case.

Constraints can be material, institutional, legal, technical, informational, ecological, temporal, organizational, financial, or symbolic. Their analytical standing depends on mechanism. A legal rule is not transformed into an economic law merely because it has economic consequences. An ecological threshold remains an ecological process even when production depends on it. A cultural meaning can affect demand or labor participation without becoming exhausted by its economic effect. GRE can model the economic pathway while preserving the causal and disciplinary identity of the contributing process where that identity matters.

Capacities are similarly heterogeneous. Financial wealth, physical infrastructure, knowledge, health, institutional recognition, social cooperation, technological access, time, legal status, organizational authority, and trusted relationships can each condition economic action. Sen's work on ethics and economics is relevant to this broader caution because it resists identifying economic assessment with a single narrow metric and keeps questions of agency and human advantage visible (Sen 1987). GRE later

develops its own account of generative capacity and heterogeneous value; the present point is narrower: a substantive economic architecture should avoid assuming in advance that economically consequential capacities are reducible to one resource form.

Constraints and capacities can co-evolve. An institution created to solve one coordination problem can generate later entry barriers. A technology that expands productive capability can make access to complementary infrastructure more consequential. A public guarantee can stabilize a market while changing expectations about future intervention. A new measurement system can make previously invisible activity governable while also narrowing attention to what the measure captures. These dynamics prepare the later GRE question of generative potential: economic architecture matters partly because it changes the conditions under which future economic architecture can be produced.

12.1.6 Cross-Domain Translation and Scope Conditions

GRE necessarily crosses disciplinary interfaces because economic relations are entangled with legal rules, political authority, social organization, technology, ecology, education, culture, health, and knowledge. Cross-domain translation can enrich economic analysis when it preserves the mechanisms and evidentiary burdens of the contributing domains. It becomes less reliable when a concept is transferred only by analogy or when economic vocabulary absorbs distinctions that remain indispensable elsewhere.

Three scope conditions are especially important in this chapter. First, similarity of relational form does not establish sameness of mechanism. Dependency in a credit relation, dependency in care, dependency in international security, and dependency in an ecological system can share structural features while differing in causal processes, normative stakes, evidence, and possible interventions. A general GR vocabulary can support comparison, but substantive GRE must justify the economic interpretation locally.

Second, economic consequence does not establish economic exhaustiveness. Law can constitute property and contractual obligation; politics can determine authority and collective decision; education can shape knowledge and credentialing; ecology can determine material reproduction; culture can organize meaning and recognition. Their economic effects can be central to GRE while their broader significance remains outside the economic account. Interdisciplinary adequacy sometimes requires parallel explanations rather than translation into a single common language.

Third, transfer across historical and institutional settings requires evidence. A mechanism observed under one property regime, technological infrastructure, household structure, labor institution, or monetary system may not transport unchanged to another. The problem is analogous to the historical transportability issues discussed in Chapter 11, but its substantive economic form can be sharper because institutions often constitute the relevant objects and relations themselves. Comparative analysis should therefore distinguish a recurrent relational pattern from a claim that the same economic mechanism operates across contexts.

These scope conditions also apply to formal analogies. Network, field, dynamical, geometric, information-theoretic, operator-algebraic, or spacetime representations can reveal structure when their variables and relations are defined with economic meaning. Their mathematical coherence alone does not establish that the economic

system instantiates the physical ontology from which the formalism may have been inspired. Ontological suspension remains in force. Formal resources are evaluated through explanatory usefulness, empirical contact, interpretability, and the discipline of their assumptions.

Caution 12.2 (Translation across domains). A concept transferred into GRE should retain a traceable account of its source meaning, the economic mechanism it is being used to represent, the evidence supporting the translation, and the respects in which the source and target domains remain different. Structural resemblance can motivate inquiry; it does not by itself establish theoretical identity.

Caution 12.2 preserves the open relation between GRE and neighboring GR domains. Legal, political, educational, ecological, historical, aesthetic, and technological analyses can correct GRE when the economic account omits mechanisms that are constitutive of the phenomenon. GRE can reciprocally contribute findings about allocation, value conversion, dependency, institutional organization, or generative foreclosure without claiming disciplinary priority over those neighboring domains.

12.1.7 GRE as a Domain Instantiation of GR

GRE can now be stated more precisely as a domain instantiation of GR. The phrase identifies an interface, not a hierarchy. GR provides a broader research space for relation, generation, historical transformation, epistemic mediation, praxis, and emergent normativity across domains. GRE develops economic questions within that space and assumes responsibility for making its objects, mechanisms, evidence, and evaluative commitments economically intelligible.

A domain instantiation has at least four consequences. The first is selective inheritance. GRE uses only those GR concepts that contribute to the economic problem at hand, and it can simplify, modify, or leave aside other resources. The second is substantive reconstruction. Economic subjects, entities, relations, institutions, resources, capacities, and fields require their own empirical and historical specification rather than receiving complete definitions from general theory. The third is reciprocal revision. Economic findings can expose limitations in GR and can motivate new general concepts, while developments in other GR domains can challenge assumptions embedded in GRE. The fourth is boundary accountability. GRE should be able to state why a problem is being treated economically and where its claims depend on neighboring disciplines.

This standing also qualifies the term *relational architecture*. Chapter 12 does not propose that one universal architecture underlies every economy. It develops a vocabulary for reconstructing how economically consequential subjects, entities, relations, boundaries, organizations, institutions, markets, households, commons, platforms, infrastructures, resources, capacities, ownership structures, transfers, labor relations, dependencies, symbolic representations, and multiscale histories are configured in particular settings. Some categories will be central in one setting and marginal in another. New categories can become necessary as economies change.

The architecture is generative because its significance extends beyond a snapshot of current organization. Economic configurations can reproduce or transform the capacities, constraints, relations, institutions, and possibilities from which later economic configurations emerge. This temporal orientation does not make generativity a synonym for improvement. An architecture can generate productive capability, co-

operation, knowledge, or new options; it can also generate dependence, exclusion, concentration, ecological degradation, vulnerability, or foreclosure. Evaluation therefore remains separate from the descriptive fact that a configuration has downstream generative effects.

The chapter develops the substantive components of that architecture progressively. Section 312 examines the standing of economic reality under the generative-relational view. Section 313 then makes explicit the GR ontological coordinates through which the later economic object architecture is organized. Sections 314–320 develop subjects, entities, relations, higher-order relations, configurations, boundaries, and internal–external coupling. Later sections examine organizations, institutions, markets, households, commons, platforms, infrastructures, resources, capacities, access, ownership, transfer, labor, coordination, dependence, asymmetry, symbolic relations, topology, fields, multiscale history, and generative potential. The progression moves from economic specificity and ontological coordination toward increasingly composite economic architectures and the conditions through which their later possibilities are produced.

The return to economics therefore marks a change of analytical responsibility. General GR supplied a provisional language for asking how relations, histories, representations, knowledge, and interventions are organized. GRE must now show, case by case and model by model, how those abstractions become economically meaningful. The task begins with economic reality itself: how economic entities and relations acquire sufficient stabilization, manifestation, recognition, and causal efficacy to function as objects of substantive economic inquiry while remaining historically revisable. Section 312 takes up that problem.

12.2 Economic Reality under the Generative Relational View

The role of this section is to specify the ontological standing of the economic objects that Chapter 12 will subsequently analyze. Its objective is to explain how prices, property positions, organizations, obligations, monetary relations, labor roles, institutional categories, expectations, resource access, and other economically consequential formations can be treated as real for economic inquiry while remaining historically generated, relationally sustained, only partially manifested, and open to revision. The discussion proceeds through relational emergence, stabilization, persistence, causal efficacy, manifestation, institutional recognition, historical revisability, and ontological restraint. The method is reconstructive and register-sensitive. It applies the three-register architecture developed in Chapter 4 to the economic domain without converting that architecture into a claim that all economic reality has one metaphysically fundamental form.

Section 12.1 established that economic specificity is historically and problem-relative. The present section adds a second qualification: economic reality should not be identified simply with whatever is currently measurable, legally recognized, priced, recorded, or administratively classified. Those manifestations and recognitions can be exceptionally important because they organize action and can become causally efficacious in their own right. Their importance does not make them exhaustive. Economic inquiry may need to reconstruct relations that are only partially

Table 12.2: Analytical dimensions of economic reality in the present GRE framework. The distinctions separate relational emergence, manifestation, institutional recognition, and historical revision while allowing them to interact recursively.

Dimension	Analytical question	Illustrative economic forms
Relational emergence	Which patterned relations, constraints, capacities, and differences have become sufficiently organized to matter for subsequent economic processes?	Exchange expectations, credit relations, labor coordination, household provisioning, platform dependence, monetary acceptance.
Stabilization and persistence	Through which recurrent practices, infrastructures, rules, records, expectations, or feedbacks does the configuration retain recognizable continuity?	Contracting routines, settlement systems, organizational procedures, property registries, standards, accounting practices.
Causal efficacy	Which later possibilities, costs, obligations, capacities, expectations, or allocations are altered by the configuration?	Borrowing conditions, access rights, hiring possibilities, prices, investment decisions, exclusion, bargaining positions.
Manifestation	Through which observable, experiential, symbolic, quantitative, or behavioral forms does the configuration become accessible?	Prices, wages, invoices, transactions, queues, inventories, balance sheets, classifications, reported preferences.
Institutional recognition	Which organizations or rule systems assign statuses, rights, obligations, categories, or authoritative records to the configuration?	Legal ownership, corporate personality, licenses, currencies, employment status, eligibility classifications, accounting recognition.
Historical revisability	Which changes in relations, rules, technologies, meanings, or practices could modify or dissolve the configuration?	Institutional reform, technical change, collective action, crisis, category revision, new infrastructures, changing conventions.
Ontological restraint	Which claims concern analytical usefulness and causal reality, and which would require stronger metaphysical commitments?	Relational, network, field, dynamical, or institutional representations used with stated scope conditions.

visible in official categories, and it may need to study how categories themselves participate in producing the economic realities they purport to describe. Historical work on the construction of the modern economy as a governable object, the institutional production of statistical comparability, and the historical formation of classificatory objects illustrates why this distinction matters (Mitchell 1998; Desrosières 1998; Hacking 2002).

Table 12.2 summarizes the principal distinctions used in this section. The table is analytical rather than exhaustive. A single economic phenomenon can occupy several rows simultaneously, and the relevant resolution can change with the inquiry.

12.2.1 Relational Emergence of Economic Reality

Chapter 4 introduced *relational reality* as a register in which configurations can acquire sufficient persistence, stability, and causal efficacy to function as real conditions of later processes without requiring a claim that the configuration is metaphysically

fundamental. Chapter 4 developed this criterion in domain-general form through its account of relational reality. Economic reality can be approached as a domain-specific application of that idea: an economic formation becomes relationally real for an inquiry when its organization makes a material difference to economically relevant possibilities, actions, expectations, constraints, capacities, or subsequent relations over the scale and interval being studied.

This formulation permits familiar economic objects to be treated seriously without assuming that their boundaries or identities were given in advance. Money, firms, property, occupations, markets, creditworthiness, household roles, platform statuses, and accounting categories can emerge through histories of practice, recognition, coordination, rule formation, material infrastructure, and representation. Their historical construction does not make them unreal. Once sufficiently stabilized, they can condition what actors can buy, owe, own, inherit, produce, access, refuse, expect, or contest. Berger and Luckmann's account of institutionalization and objectivation, and Searle's analysis of institutional facts and status functions, provide influential but distinct accounts of how socially constituted forms can acquire practical reality (Berger and Luckmann 1966; Searle 1995). GRE draws on the general insight that constituted objects can become causally consequential while leaving the deeper ontology of such constitution open.

Relational emergence is therefore compatible with several pathways. Some economic formations arise through repeated decentralized interaction. Others depend heavily on legislation, administration, organizational design, technical standards, or material infrastructures. Some emerge through combinations of these processes. A currency can depend on legal authority, settlement infrastructure, accounting convention, taxation, expectation, and repeated acceptance. A market can depend on participants, rules, venues, informational systems, property arrangements, standards, and expectations. A firm's economic reality can involve legal recognition together with organizational routines, assets, contractual relations, authority structures, reputational histories, and continuing coordination. The relevant object is reconstructed through the relations that make it consequential for the question at hand.

This position also preserves scale sensitivity. A relation can be real at one analytical scale while remaining negligible at another. A local reciprocal arrangement can organize household provisioning without appearing in national accounts. A national monetary policy regime can strongly condition local credit while being only one background factor in a particular transaction. A platform rule can be operationally decisive for a seller while constituting one component of a much larger market architecture. Economic reality therefore depends partly on the selected scale, but scale dependence does not reduce the phenomenon to analyst discretion. The inquiry remains answerable to evidence about whether the posited configuration actually constrains, enables, coordinates, or redirects relevant processes.

Definition 12.3 (Relationally real economic configuration). A *relationally real economic configuration* is a historically situated organization of relations, structures, constraints, capacities, differences, practices, or representations that exhibits sufficient persistence and causal efficacy to condition economically relevant processes at a specified scale and over a specified interval.

Definition 12.3 is deliberately conditional. It does not imply that every recurring economic pattern constitutes a stable entity, that every economic category has the same mode of reality, or that the relevant configuration is permanent. It supplies

a criterion for taking constituted economic formations seriously while retaining the possibility that their boundaries, mechanisms, and duration will differ across cases.

12.2.2 Stabilization

Stabilization concerns the processes through which an economic configuration acquires enough patterned continuity to become identifiable and consequential across events. It can arise through repetition, expectation, coordination, rule enforcement, technical standardization, material embedding, record keeping, classification, socialization, investment, or feedback from previous outcomes. North's institutional analysis, for example, emphasizes how rules and constraints structure interaction and how institutional change shapes economic performance over time (North 1990). GRE treats such institutional mechanisms as one family among several possible stabilizing processes.

Stabilization should be distinguished from immobility. A configuration can remain recognizable while its participants, manifestations, technologies, and internal relations change. A firm can persist through employee turnover and strategic change; a market can persist while products, participants, and prices vary; a monetary arrangement can retain continuity through technical changes in settlement; a household can remain an economically consequential unit while its membership and internal allocation practices change. What persists is therefore often an organization of relations or a reproducing capacity rather than an unchanged inventory of components.

Economic stabilization can also be recursive. A representation generated within an economic configuration can feed back into later economic relations. Credit scores can affect access to credit; rankings can redirect attention and investment; accounting categories can shape organizational planning; price histories can influence expectations; recognized property titles can support transactions that further reproduce the institutional standing of those titles. Chapter 4 treated this more generally through recursive stabilization and transformation among relational reality, manifestation, and representation. In the economic domain, such feedback makes it especially important to distinguish the stabilization of a practical category from confirmation that the category is descriptively complete or normatively justified.

Stabilization may be uneven. Some components of an arrangement can be strongly institutionalized while others remain contested or informal. A labor relation can be contractually stabilized while expectations concerning effort, care, loyalty, flexibility, or availability remain tacit. A platform can formalize transaction procedures while leaving important dependencies outside its explicit categories. A market can have standardized prices and products while the social relations that enable participation remain heterogeneous. Economic reality can therefore possess a stable public interface together with a more variable relational substrate.

For GRE, the practical question is often which mechanisms sustain the apparent continuity. A pattern maintained by legal enforcement differs from one maintained primarily by convention, infrastructural dependence, repeated reciprocity, reputational expectation, or concentrated control over access. The distinction matters because different stabilization mechanisms imply different vulnerabilities and different pathways of transformation. Later sections on organizations, institutions, platforms, ownership, access, and dependence develop these mechanisms more specifically.

12.2.3 Persistence

Persistence concerns the temporal extension of an economic configuration once some degree of stabilization has emerged. GRE treats persistence as relative to a timescale and resolution. A transaction may persist for minutes, a contractual relation for years, an infrastructure for decades, and an institutional category across several generations. These durations are analytically different, yet each can matter if it conditions subsequent economic histories.

Persistence can be active rather than passive. Maintaining a supply chain requires recurring coordination; maintaining a property regime requires records, adjudication, recognition, and enforcement; maintaining a currency requires settlement, accounting, institutional support, and continuing practices of acceptance; maintaining organizational knowledge requires memory systems, training, routines, or personnel continuity. Apparent stability can therefore depend on substantial continuing work. The absence of visible change at one level can coexist with continuous reproduction at another.

Historical persistence also creates path dependence. Investments, infrastructures, classifications, contractual forms, skills, expectations, and organizational routines can make some later transformations easier and others more costly. This does not imply that the past mechanically determines the future. It means that earlier events can alter the later field of feasible or attractive possibilities. Chapter 4 developed the historical materiality of ontological categories, while Parts III and IV treated historical trajectories as relevant to inquiry and action. Chapter 12 now applies those commitments to economic architectures in which persistence itself can become a source of capability, dependence, lock-in, memory, or coordination.

Persistence should also be separated from normative desirability. An exploitative arrangement, exclusionary classification, fragile dependency, or concentrated control structure can persist effectively. Conversely, a normatively valued arrangement can remain institutionally fragile. GRE therefore uses persistence as a descriptive and explanatory property. Normative evaluation requires additional considerations concerning value, justice, capability, power, care, rights, ecological consequence, or other relevant commitments developed elsewhere in the book and neighboring domains.

Remark 12.4 (Persistence and viability). Persistence records continuation across a relevant interval. Viability concerns whether a configuration can continue under specified conditions while reproducing the capacities, resources, relations, or functions relevant to the inquiry. Neither property establishes that continuation is normatively desirable. In some settings, the practical objective may concern transformation or dissolution rather than preservation.

Remark 12.4 carries forward the restraint introduced in Chapter 11. GRE can study the conditions under which economic relations persist or remain viable without elevating sustainability, stability, or reproduction into universal goods.

12.2.4 Causal Efficacy

Causal efficacy distinguishes an economically consequential configuration from a pattern that is merely named or observed. Within the present framework, causal language is used broadly enough to include mechanisms represented through statistical, processual, institutional, historical, network, dynamical, interpretive, or other

warranted modes of inquiry. The relevant requirement is that the proposed configuration contributes to differences in later possibilities, events, relations, constraints, capacities, or manifestations under the scope conditions of the analysis.

Economic causal efficacy can operate through material channels. Infrastructure can alter transport costs and feasible production locations. Ownership can condition access to assets. Collateral requirements can affect borrowing possibilities. Technical standards can determine interoperability. It can also operate through institutional and symbolic channels. A legally recognized status can create rights and obligations; a rating can alter financing conditions; an accounting classification can change organizational decisions; a market expectation can influence present behavior. Granovetter's analysis of embedded economic action is relevant here because it shows how ongoing relational structures can materially affect economic behavior and institutional outcomes (Granovetter 1985).

The causal efficacy of representations is especially significant for GRE. A representation can enter the field it describes and thereby change subsequent relations. A forecast can influence expectations, a category can determine eligibility, an index can redirect investment, and a performance metric can reorganize behavior around what is measured. Merton's classic analysis of self-fulfilling prophecy provides an early formulation of a related feedback structure in which a consequential definition of a situation helps generate behavior that changes the later situation (Merton 1948). Chapter 5 and Chapter 11 generalized this issue through performative representation and epistemic events. Economic reality provides many settings in which such feedback becomes empirically consequential.

Causal efficacy remains compatible with partial observability and multiple realization. The same observed price change can arise from different combinations of demand, supply, market structure, expectations, policy, technical disruption, or strategic interaction. The same institutional category can influence actors through different mechanisms across groups or periods. Conversely, a common relational mechanism can manifest differently under different legal or technological arrangements. GRE therefore does not infer mechanism solely from manifestational regularity. Causal claims require evidence appropriate to the question, and the admissible methods remain plural.

A further implication concerns absence and counterfactual structure. Economic conditions can be causally consequential through unavailable options, inaccessible institutions, missing infrastructure, unrecognized rights, or prohibitive constraints. The relevant economic reality is therefore not exhausted by observed transactions. What actors cannot access, cannot credibly choose, or cannot sustain can be as consequential as what becomes manifest in completed exchange. Later sections on capacities, constraints, and access develop this point directly.

12.2.5 Manifestation

Manifestation concerns the forms through which economic reality becomes perceptible, recordable, reportable, measurable, symbolizable, or experientially available. Chapter 4 introduced manifestational reality in domain-general form and developed manifestation mappings, their relational standing, symbolic mediation, and possible non-invertibility. Economic analysis depends heavily on such mappings because many of its empirical objects arrive through prices, quantities, accounts, surveys, con-

tracts, legal records, administrative databases, ratings, classifications, narratives, interfaces, observed behavior, or embodied experience.

Manifestation is indispensable for empirical inquiry, yet no single manifest form should be presumed to exhaust the underlying economic configuration. A wage records one aspect of an employment relation while leaving authority, security, care burdens, scheduling control, workplace knowledge, social meaning, or bargaining dependence only partially represented. A price can condense a market transaction while leaving outside the price many conditions that made participation possible. A balance sheet can make organizational resources and obligations legible under an accounting regime while omitting relationships or capacities that the accounting framework does not recognize. A national statistic can support comparison while aggregating heterogeneous histories into a common category.

The relation can also run in the other direction: economic relations can become consequential before they acquire standardized manifestation. Informal care, emerging technical practices, unrecorded reciprocal obligations, tacit knowledge, or new forms of digital labor can affect economic possibilities before statistical or legal systems classify them adequately. The later creation of a category can increase visibility, comparability, and governability, but it may also reorganize behavior around the new representation. Historical work on statistical reasoning and economic representation demonstrates how measurement systems participate in constructing fields of comparability and governance (Desrosières 1998; Mitchell 1998).

The non-invertibility of manifestation developed in Chapter 4 is therefore central to substantive GRE. Similar manifestations can be compatible with different relational configurations, and a single relational configuration can produce different manifestations under changing institutional or technological conditions. Reverse inference from an economic indicator to the history and relation that produced it consequently requires additional assumptions and evidence. This issue becomes especially important when policy, credit, employment, welfare, or automated decision systems use manifest variables as proxies for less directly observed capacities or conditions.

Caution 12.5 (Manifestational compression). Economic manifestations can make complex relations operationally tractable while compressing differences that remain relevant to explanation or judgment. GRE therefore treats prices, indicators, classifications, records, and model variables as epistemically consequential manifestations whose adequacy depends on the purpose, scale, history, and relations being studied.

Caution 12.5 does not diminish the importance of measurement. Operational representations can be indispensable for coordination, comparison, testing, and intervention. The caution identifies a reconstruction problem: the more consequential a manifest variable becomes for action, the more important it may be to understand both what it captures and what its production suppresses or leaves unrepresented.

12.2.6 Institutional Recognition

Institutional recognition concerns the processes through which organizations, legal systems, administrative systems, professional practices, accounting regimes, standards bodies, platforms, or other rule-governed structures assign an economically consequential status to a person, object, relation, event, or representation. Recognition can create rights, duties, permissions, exclusions, eligibility, ownership, organizational identity, monetary acceptability, contractual standing, or authorita-

tive records. Searle's account of status functions and collective recognition provides one influential framework for understanding institutional facts, while Berger and Luckmann emphasize the historical processes of institutionalization, objectivation, legitimation, and socialization (Searle 1995; Berger and Luckmann 1966).

GRE treats institutional recognition as one mechanism through which economic reality can be stabilized and transformed. Legal incorporation can make an organization capable of holding assets or entering contracts. Registration can make ownership enforceable against third parties. Licensing can alter who may participate in an occupation or market. Accounting recognition can determine whether an item enters an organization's formal representation of assets, liabilities, revenue, or cost. Administrative classification can open or close access to benefits, credit, procurement, or regulated activities. These recognitions matter economically because they alter practical capacities and constraints.

Institutional recognition and relational reality nevertheless remain analytically distinct. A relation can be economically consequential without formal recognition. Informal work, tacit obligations, community stewardship, unregistered possession, shadow credit, or care relations can structure economic life outside official categories. Conversely, an institution can recognize a formal status whose practical efficacy varies because enforcement, resources, infrastructure, knowledge, or social acceptance are weak. The existence of a category and the effective operation of the relation it names are therefore separate empirical questions.

Recognition can also be contested and plural. Different institutions may classify the same activity differently. Legal, accounting, tax, statistical, platform, and community categories can overlap incompletely. A worker may be treated as an independent contractor under one regime, as economically dependent under another analysis, and as part of a collective production process under a third. GRE should therefore identify which institution performs the recognition, what consequences follow from that recognition, and where competing classifications remain consequential.

Institutional recognition can become recursive. Once a status changes access, rights, expectations, or investment, behavior can reorganize around the status. The resulting pattern can strengthen the practical importance of the classification, even when the original boundary was contingent or contested. Hacking's historical ontology is useful here because it directs attention to how classifications and the objects available for inquiry can emerge together historically (Hacking 2002). GRE extends this concern into economic settings where recognition can change resource flows, incentives, organizational boundaries, and later possibilities.

12.2.7 Historical Revisability

Historical revisability follows from the generative character of economic reality. A configuration that is sufficiently real to organize present economic life can still be transformed by later events. Property regimes change, currencies are replaced, firms dissolve, occupations appear and disappear, markets are reorganized, accounting standards change, household structures evolve, infrastructures are rebuilt, and categories of legitimate economic activity shift. The reality of these formations during a period does not require their permanence.

Revisability occurs through several pathways. Relations can change because participants alter practice. Institutions can revise rules or recognition. Technologies can

change feasible forms of coordination and control. New representations can make previously obscure relations visible. Crises can disrupt stabilizing feedback. Political or legal transformations can redistribute authority. Ecological change can alter material constraints. New knowledge can revise the categories through which an economic field is interpreted. These pathways can interact, and their relative importance is an empirical question rather than a fixed GR sequence.

Historical revisability also applies to the analyst's categories. Terms such as *labor*, *capital*, *market*, *firm*, *household*, *asset*, *platform*, or *data* can acquire different practical meanings as institutions and technologies change. Mitchell's analysis of the historical formation of the modern economy and Hacking's work on historical ontology provide reminders that objects of knowledge can have histories of constitution alongside histories of the phenomena they organize (Mitchell 1998; Hacking 2002). GRE therefore treats its own vocabulary as revisable when changing economic reality makes existing distinctions inadequate.

This revisability should not be confused with unrestricted conceptual relativism. A historical category can still be studied rigorously. Claims about its emergence, scope, causal efficacy, distribution, or transformation remain answerable to evidence. The point is that evidential discipline does not require the category to be timeless. Historical specificity can itself become part of the explanatory burden.

Proposition 12.6 (Historical reality and revisability). *Within the present GRE framework, the historical revisability of an economic configuration is compatible with its relational reality when the configuration exhibits sufficient persistence and causal efficacy over the scale and interval relevant to the inquiry.*

Proposition 12.6 prevents two opposite errors. One would deny reality to constituted or historically contingent economic forms because they could have been otherwise. The other would treat present institutional forms as natural or permanent because they are currently stable and consequential. GRE instead studies how contingency can become structured, how structure can become causally effective, and how causally effective structures can later transform.

12.2.8 Ontological Restraint

Ontological restraint governs the interpretation of every preceding subsection. GRE uses relational emergence, stabilization, persistence, causal efficacy, manifestation, institutional recognition, and historical revisability as analytical resources. Their usefulness does not establish that economic reality is ultimately composed of relations, fields, networks, events, operators, institutions, or any other single class of object. Chapter 4 called this stance ontological suspension and clarified the methodological standing and limits of GRE's ontological claims.

The restraint is particularly important because later chapters employ formal languages inspired by several disciplines. A network representation can capture connectivity, brokerage, dependence, or bottlenecks. A dynamical model can represent trajectories and transitions. A field representation can describe distributed conditions. Operator or event-complex formalisms can organize histories and transformations. Each can become analytically powerful under suitable assumptions. None acquires ontological priority merely because its mathematics is coherent or its predictions are useful.

Ontological restraint also protects economic plurality. Property, money, organi-

zations, households, markets, care relations, platforms, infrastructures, knowledge, and ecological conditions need not share one mode of constitution. Some depend strongly on legal recognition; some rely more heavily on practice and convention; some are materially constrained; some are technologically mediated; most combine several mechanisms. GRE can therefore compare them through a common relational-generative vocabulary while allowing the substantive ontology of each case to remain heterogeneous and partly open.

A restrained ontology still permits strong local claims. An empirically supported analysis can establish that a particular classification affects access, that an infrastructure creates a bottleneck, that a contractual arrangement stabilizes a dependency, or that a representation changes subsequent behavior. The restraint concerns the movement from such warranted local findings to claims about ultimate reality. It does not require withholding conclusions that are supported within clearly stated scope conditions.

Remark 12.7 (Economic reality as an empirical and theoretical responsibility). Calling an economic configuration relationally real creates an explanatory responsibility. The inquiry should identify the relevant scale and interval, the relations or structures that sustain the configuration, the manifestations through which it is accessed, the mechanisms through which it becomes causally consequential, and the conditions under which the configuration may transform. The designation is therefore a research commitment rather than a metaphysical shortcut.

Remark 12.7 provides the bridge to the remainder of Chapter 12. Economic reality has now been specified as historically constituted yet capable of persistence and causal efficacy, accessible through incomplete manifestations, often mediated by institutional recognition, and open to later transformation. Before the chapter specializes this reality into economic subjects, entities, relations, and other substantive forms, Section 12.3 makes explicit the domain-general ontological coordinates through which those later objects are organized. That coordination clarifies how constraint, change, structure, difference, entity, event, relation, property, state, and process enter the economic architecture without assigning any one of them universal priority.

12.3 Ontological Coordinates of Economic Architecture

The role of this section is to make explicit the ontological organization that guides the remainder of Chapter 12. Its objective is to show how the economic object architecture developed in this chapter relates to the domain-general Generative Relational (GR) distinctions of constraint, change, structure, and difference, together with the emergent analytical forms of entity, event, relation, property, state, and process. The discussion proceeds from these two layers to their economic specification, their many-to-many correspondence with later chapter sections, and several categories that require particular care in economic use. The method is reconstructive rather than foundational: the section does not introduce a new ontology for economics, and it does not treat the listed categories as metaphysically final. It provides a domain map that helps readers understand why the later economic concepts appear, how they are related, and where additional concepts may become necessary.

The need for this map follows from the architectural objective of the chapter. Terms such as organization, market, ownership, labor, access, dependence, institution, or allocation are not situated at one uniform ontological level. A market can be represented as a relational configuration, a structure, a historical process, a locus of events, and a state of an economic field at a selected analytical cut. An organization can function as an entity at one scale while being reconstructed internally as a changing structure of relations, roles, properties, states, and processes. The same economic phenomenon can therefore require several ontological coordinates at once. A one-to-one taxonomy would conceal this compositional character.

12.3.1 Domain Specification of GR Ontology

GR uses a deliberately restrained ontological vocabulary. At a preliminary analytical layer, *constraints*, *changes*, *structures*, and *differences* provide general resources for describing how a configuration is organized and how it can vary. At a more articulated layer, *entities*, *events*, *relations*, *properties*, *states*, and *processes* provide recurrent object forms through which histories can be reconstructed. Earlier parts of the book treated these categories as analytical resources under ontological suspension rather than as proof of a final metaphysical inventory.

Economic specification gives these categories domain content. A constraint can appear as a material limit, an institutional rule, a financial commitment, a technical dependency, a time requirement, or a relational barrier. A change can appear as transfer, entry, exit, learning, reclassification, price adjustment, organizational reconfiguration, institutional reform, or dissolution. A structure can appear in ownership, governance, infrastructure, network position, market organization, household provisioning, or institutional arrangements. A difference can appear in role, status, capability, access, history, resource position, exposure, or representation without necessarily constituting an asymmetry or hierarchy.

The emergent object forms are specified in the same way. An entity can be a person, firm, household, account, asset, organization, or other stabilized economic object relative to the inquiry. An event can be a transaction, recognition, default, hiring, dismissal, entry, exit, transfer, policy enactment, classification, allocation, or other selected occurrence that changes or records an economically relevant configuration. A relation can be exchange, labor, ownership, care, credit, authority, trust, dependence, or another economically consequential connection. A property can describe an attributed characteristic of an entity, relation, or configuration, such as a resource holding, legal status, capability, centrality, access condition, or exposure. A state can represent a selected configuration at an event-relative or temporal cut. A process can represent temporally extended and structured change, such as production, circulation, learning, institutional reproduction, labor, coordination, or reorganization.

These economic specifications remain scale- and purpose-sensitive. The same object can occupy different ontological roles at different resolutions. A long-term contractual relation can be modeled as a relation between two firms, as an entity-like object within a portfolio of contracts, as a state within a larger supply configuration, or as a process constituted by negotiation, performance, revision, and enforcement events. The analytical role should therefore be stated through the question and mechanism under study.

Table 12.3: Preliminary GR coordinates and their principal economic specifications in Chapter 12. The section loci identify recurrent concentrations rather than exclusive ownership of a category.

GR category	Economic specification	Principal chapter loci
Constraint	Conditions that restrict, channel, condition, or make costly specified economic actions, relations, or transformations.	Economic reality and stabilization (Section 12.2); capacities and constraints (Section 12.17); access (Section 12.18); dependence (Section 12.22); generative potential (Section 12.27).
Change	Economically consequential alteration in configuration, relation, status, position, resource, representation, or feasible history.	Entity and configuration transformation (Sections 12.5 and 12.8); transfer and circulation (Section 12.20); historical architecture (Section 12.26); allocation (Section 12.28).
Structure	Patterned organization through which relations, positions, rules, boundaries, and dependencies acquire recurrent economic significance.	Relational configurations (Section 12.8); organizations, institutions, markets, households, and infrastructures (Sections 12.11–12.15); topology and fields (Section 12.25).
Difference	Non-identity among positions, histories, roles, capacities, properties, states, or relations that can become economically consequential.	Heterogeneous subjecthood (Section 12.4); boundaries and membership (Section 12.9); differentiated access (Section 12.18); asymmetry (Section 12.23); differentiated generative potential (Section 12.27).

12.3.2 Primitive Coordinates of Economic Architecture

Table 12.3 summarizes how the four preliminary GR coordinates recur in the economic architecture developed in this chapter. The loci are illustrative. Each coordinate appears across several sections, and a later economic concept may combine several coordinates simultaneously.

Difference deserves particular care because it is more general than asymmetry. Two economic subjects can differ in role, history, institutional status, temporal position, relation-form, or representation without possessing an ordered advantage or disadvantage. Asymmetry, developed later in Section 12.23, is one possible organization of difference under a specified dimension. The primitive category therefore keeps open forms of heterogeneity that cannot or should not be ranked on one scale.

Constraint also has broader scope than prohibition. A condition can constrain by raising cost, delaying action, narrowing feasible conversion, shaping coordination, requiring complementary resources, or changing the histories that remain accessible. Some constraints can simultaneously enable stable interaction. Their economic role depends on the configuration and horizon in which they operate.

12.3.3 Emergent Economic Object Forms

The six emergent analytical forms provide a more articulated grammar for economic reconstruction. Table 12.4 identifies their working economic interpretations and prin-

Table 12.4: Emergent GR object forms and their economic specification in Chapter 12. A single empirical object can legitimately occupy several rows at different scales or for different questions.

Object form	Working economic interpretation	Principal chapter loci
Entity	A sufficiently stabilized and trackable economic object relative to a stated inquiry and resolution.	Economic subjects and entities (Sections 12.4–12.5); organizations and other stabilized forms (Sections 12.11–12.15).
Event	A selected occurrence in an economic history through which a relevant configuration is changed, recognized, recorded, or made consequential.	Event-historical subject and entity representations (Sections 12.4–12.5); transfers and circulation (Section 12.20); epistemic events (Section 12.24); historical architecture (Section 12.26); allocation (Section 12.28).
Relation	An economically consequential connection or conditioned co-position among subjects, entities, roles, rules, resources, or processes.	Economic and higher-order relations (Sections 12.6–12.7); configurations and internal-external coupling (Sections 12.8–12.10).
Property	An attributed characteristic of an economic entity, relation, event, state, process, or configuration whose relevance is specified by the inquiry.	Resources, capacities, access, ownership/control, dependence, asymmetry, and topological position (Sections 12.16–12.25).
State	A selected representation of an economic configuration at a specified event-relative or temporal cut, including the relevant relations, positions, properties, and constraints.	Economic reality (Section 12.2); relational configurations (Section 12.8); market, institutional, access, and field conditions (Sections 12.12–12.25).
Process	A temporally extended organization of changes and events whose continuity or mechanism is analytically relevant.	Production, labor, transfer, circulation, coordination, learning, institutional reproduction, historical transformation, and allocation (Sections 12.6, 12.11–12.28).

cipal loci in the chapter. The categories remain mutually composable rather than mutually exclusive.

The table does not imply that economic analysis should encode each case in all six forms. A price adjustment can be treated as an event when the timing of change is central, as a state variable in a quantitative model, as a property of a market observation, or as one component of a longer adjustment process. The appropriate representation depends on the explanatory task and available evidence.

12.3.4 Many-to-Many Ontological Correspondence

The relationship between GR ontology and substantive economic concepts is many-to-many. A market, organization, household, platform, property regime, or labor ar-

rangement usually combines several ontological forms. Conversely, one ontological form can be instantiated through many economic objects. This compositional relation is important because it prevents the chapter from treating familiar economic nouns as ontologically homogeneous.

Proposition 12.8 (Many-to-many ontological correspondence). *Within the present GRE architecture, the mapping between domain-general ontological coordinates and economic concepts is generally many-to-many. An economic concept may combine several ontological forms, and the same ontological form may be realized through heterogeneous economic objects. Analytical adequacy therefore depends on identifying which forms and mechanisms matter for the question rather than assigning each concept to a single ontological class.*

Proposition 12.8 gives the chapter an organizational principle. Sections on organizations, institutions, markets, households, infrastructures, resources, ownership, labor, coordination, and representation should be read as domain-specific configurations assembled from more general ontological resources. Their section boundaries serve exposition and inquiry; they do not imply that economic reality is naturally partitioned into twenty-eight independent kinds.

This principle also supports ontological restraint. A network representation can emphasize relations and structure; an event-complex representation can emphasize events, histories, and higher-order composition; a state-space representation can emphasize properties and state transitions; an institutional history can emphasize rules, processes, and changes. GRE can use several of these representations for the same economic field when they disclose different mechanisms, provided their scopes and translations remain explicit.

12.3.5 Economic Events and Event Histories

Events deserve explicit treatment because the historical orientation of GR cannot be reconstructed only from stable entities and relations. An economic event is a selected occurrence whose role in an inquiry is to mark or enact an economically relevant change, recognition, commitment, observation, transfer, decision, or transformation. Event boundaries are analytical and evidential: a transaction can be represented as one event at one scale and as a process containing negotiation, authorization, settlement, delivery, and recording events at another.

Economic time can consequently be represented through partial order among events where scalar clock time does not capture the whole structure. Contract authorization can precede settlement; institutional recognition can precede access; an informational event can precede a decision; two geographically separated production events can remain unordered relative to one another while both precede a later assembly event. Clock time can be attached when available, while precedence, dependence, and generative accessibility remain analytically distinguishable.

The event perspective also clarifies why the chapter repeatedly treats histories as consequential. A present ownership status, credit position, organizational role, market access condition, or institutional classification can depend on event history even when the current manifested state appears identical to another case. Event histories therefore supply causal and interpretive information that a static economic state may compress.

12.3.6 Economic Properties, States, and Processes

Properties, states, and processes are present throughout economic analysis even when they are not named explicitly. Their separation helps prevent several common compressions. A *property* is an attributed characteristic whose relevance is stated relative to an object and inquiry. A resource holding, legal status, access condition, capability, centrality measure, liability, membership category, or exposure can function as an economic property. GRE does not presume that such properties are intrinsic; many are relational, institutional, historical, or representationally produced.

An economic *state* is a selected representation of a configuration at a specified temporal or event-relative cut. A state can include entities, relations, properties, constraints, and institutional conditions. It is therefore a representation of what is taken to obtain at that cut rather than a complete inventory of economic reality. Two configurations can share selected state variables while differing in histories, latent relations, unobserved constraints, or transition potentials.

An economic *process* is a temporally extended organization of changes and events for which continuity, sequencing, mechanism, or reproduction matters to the inquiry. Production, labor, care, circulation, institutional reproduction, organizational learning, coordination, market formation, and allocation can each be represented as processes at an appropriate resolution. A process can contain events and pass through several states while also transforming properties, relations, or entities.

Remark 12.9 (State–history non-equivalence). A state description can be sufficient for some economic questions while remaining insufficient for questions whose mechanisms depend on trajectory, sequence, accumulated obligation, institutional memory, or path dependence. GRE therefore preserves both state-based and event-historical representations where the distinction changes explanation.

12.3.7 Chapter-Level Ontological Correspondence

Table 12.5 provides a higher-level map of the chapter’s organization. It shows why the sequence begins with economic specificity and reality, develops object and relational forms, then turns to stabilized social configurations, capacities and positions, representation, scale and history, and finally generative potential and allocation. The rows are architectural blocks rather than ontological levels.

This map explains the chapter’s ordering without converting it into a rigid derivation tree. Later sections can draw on earlier object forms, and later economic cases can reveal that a category introduced earlier requires revision. The organization is therefore cumulative in exposition while remaining recursive in theory.

12.3.8 Coverage and Open Extension

The ontological map also provides a way to identify underdeveloped concepts. Entity and relation receive direct and extensive treatment in the chapter. Event, property, state, and process are distributed across many sections and therefore require the explicit coordination supplied here. Difference appears throughout heterogeneity, boundaries, access, asymmetry, and generative potential; the present section clarifies that difference is broader than ordered asymmetry. Change and constraint likewise

Table 12.5: Chapter 12 architectural blocks and their principal ontological emphasis. The mapping is deliberately many-to-many and does not imply exclusive correspondence.

Chapter block	Principal ontological emphasis	Economic function
Economic specificity and reality (Sections 12.1–12.3)	Constraint, change, structure, difference; status of emergent objects	Establishes what counts as economically relevant, what kind of reality is being attributed, and how the GR ontology is economically specified.
Subjects, entities, relations, and configurations (Sections 12.4–12.10)	Entity, relation, event, structure, difference, state	Constructs the principal economic objects and relational compositions used by later sections.
Organizations, institutions, markets, households, and infrastructures (Sections 12.11–12.15)	Structure, entity, relation, property, process	Examines recurrent stabilized social-economic forms through which collective economic activity is organized.
Resources, capacities, access, ownership, transfer, labor, coordination, and asymmetry (Sections 12.16–12.23)	Property, relation, constraint, difference, process, change	Describes economically consequential positions, capabilities, flows, dependencies, and transformations.
Representation, topology, scale, and history (Sections 12.24–12.26)	Property, state, relation, event, process, structure	Develops representational and historical languages for reconstructing complex economic configurations.
Generative potential and allocation (Sections 12.27–12.28)	Change, process, event, constraint, difference, state transition	Examines how present architecture conditions later possibilities and how situated allocation can alter that architecture.

cut across the chapter rather than belonging to one local section.

The map should not be read as evidence that the ten coordinates exhaust economically relevant reality. New technologies, ecological relations, forms of collective agency, legal structures, symbolic practices, or scientific developments can motivate additional domain categories or revisions of the present ones. Some economic inquiries may also require concepts whose disciplinary standing remains partly external to economics, including legal validity, political authority, cultural meaning, ecological integrity, or phenomenological experience. GRE can relate to those concepts without converting them automatically into economic properties.

Remark 12.10 (Open economic ontology map). The correspondence developed in this section is a provisional organizational map for GRE. It clarifies how the present chapter instantiates existing GR categories and where those categories enter economic analysis. It does not establish that the map is complete, that every economic problem requires every category, or that future GRE work should preserve the present partition unchanged.

With this ontological coordination made explicit, the remaining sections can in-

roduce economic subjects, entities, relations, configurations, institutions, resources, and processes as domain-specific constructions whose roles can be located within the broader GR architecture without being reduced to it.

12.4 Economic Subjects

The role of this section is to specify how Generative Relational Economics identifies the configurations that can occupy economically consequential positions of participation, agency, exposure, dependence, entitlement, obligation, representation, and decision. Its objective is to develop a plural and historically revisable account of economic subjecthood that is broad enough to include persons and collective formations while preserving important differences among human persons, households, organizations, communities, institutions, public authorities, artificial agents, and non-human participants. The discussion proceeds from these heterogeneous subject forms to conditions of comparability, historical-relational representation, and one optional 2-complex model of subject histories. The method is reconstructive and scope-sensitive. Economic subjecthood is treated as an analytical role whose relevance should be justified for the inquiry at hand, while moral standing, legal personality, experiential capacity, causal agency, institutional authority, and computational action remain distinct dimensions unless an argument establishes a relation among them.

Section 12.2 described economic reality as historically constituted yet capable of persistence and causal efficacy. The present section asks which configurations within such a reality can meaningfully be treated as subjects of economic analysis. Conventional economic models often begin with already individuated consumers, workers, firms, governments, or households. Those abstractions can be highly productive when their assumptions fit the problem. GRE adds a prior reconstructive question: which configuration is being treated as the relevant subject, through which relations is that subject stabilized, what capacities are attributed to it, and what heterogeneity is suppressed when it is represented as a single unit? Granovetter's critique of atomized economic action and Sen's capability-oriented emphasis on substantive opportunities both motivate attention to the relational conditions under which economic agency is exercised (Granovetter 1985; Sen 1999).

Table 12.6 summarizes dimensions that can matter when subjecthood is attributed in economic inquiry. The dimensions are neither jointly necessary nor jointly sufficient in every application. They function as an analytical checklist for avoiding premature equivalence among heterogeneous subject forms.

The table makes one discipline especially important. A configuration can be a useful economic subject for one purpose without satisfying every other dimension of subjecthood. A corporation can enter contracts and hold assets without having human experience. A household can be treated as a unit of provisioning while containing members with divergent preferences and unequal authority. An algorithm can execute economically consequential actions while responsibility remains with persons or institutions that design, authorize, deploy, supervise, or rely on it. An ecosystem can condition economic possibilities and become an object of stewardship without thereby becoming equivalent to a legal person, a human decision maker, or a computational agent. GRE therefore uses subject language with explicit scope conditions.

Definition 12.11 (Economic subject). Within the present GRE framework, an *eco-*

Table 12.6: Selected dimensions for reconstructing economic subjecthood. The dimensions are analytically separable and can be distributed differently across persons, collective formations, institutions, artificial systems, and non-human participants.

Dimension	Analytical question	Illustrative manifestations
Participation	Through which processes does the configuration enter economically consequential relations?	Labor, exchange, care, production, consumption, contribution, regulation, stewardship, computation.
Capacity	Which actions, transformations, refusals, adaptations, or forms of coordination are feasible for the configuration?	Choice, bargaining, production, learning, rule application, resource mobilization, reconfiguration.
Exposure	Which costs, risks, constraints, losses, or dependencies can be borne by or transmitted through the configuration?	Income loss, debt, displacement, liability, ecological exposure, infrastructure dependence.
Recognition	Which statuses, identities, rights, claims, or categories are assigned by relevant institutions or communities?	Legal personhood, household status, membership, citizenship, organizational role, account identity.
Representation	Who or what can speak, decide, transact, or record on behalf of the configuration?	Authorized officers, household representatives, delegates, algorithms, trustees, public agencies.
Responsibility	Under which conditions can duties, accountability, liability, or answerability be attributed?	Contractual responsibility, fiduciary duty, administrative responsibility, professional accountability.
Experience and welfare	Does the inquiry concern lived experience, suffering, flourishing, preference, need, or capability?	Human welfare, care, deprivation, animal welfare, experienced insecurity.
Historical continuity	Which events, relations, memories, records, and transformations make the subject identifiable across time?	Personal trajectory, organizational succession, household change, institutional memory, model updates.

economic subject is a historically situated configuration that is treated, for a specified inquiry, as occupying one or more economically consequential positions of participation, capacity, exposure, claim, obligation, representation, dependence, or decision. The attribution of subjecthood should identify the relevant dimensions and should not imply equivalence across dimensions that the inquiry has not established.

Definition 12.11 is intentionally permissive at the level of analytical entry and restrictive at the level of inference. It allows economic analysis to follow consequential participation beyond the individual person while requiring the analyst to state what kind of subjecthood is actually being attributed. The following subsections develop this discipline across several recurrent subject forms.

12.4.1 Persons

Persons remain a central economic subject because economic processes can affect their opportunities, labor, consumption, care, security, knowledge, time, health, mo-

bility, obligations, and capacity to participate in collective life. GRE does not reduce personal subjecthood to preference expression or market choice. A person can occupy several economic positions simultaneously: worker, caregiver, debtor, owner, tenant, learner, consumer, citizen, family member, creator, beneficiary, contributor, or participant in informal relations that are only partially represented in conventional economic categories. Which positions matter depends on the inquiry.

A relational treatment of persons does not dissolve individuality. It asks how personal capacities and constraints are partly constituted through relations with other persons, organizations, institutions, infrastructures, technologies, legal statuses, environments, and accumulated histories. Sen's capability approach is relevant because it distinguishes resources from the substantive opportunities that persons are actually able to realize and emphasizes the role of social arrangements in expanding or constraining those opportunities (Sen 1999). GRE extends the same caution to relational position: identical nominal resources can have different practical significance when access, knowledge, recognition, dependency, care burdens, mobility, institutional treatment, or social position differ.

Personal economic subjecthood is also historical. Skills are acquired; debts accumulate or are discharged; reputations develop; legal statuses change; family responsibilities emerge; health and mobility can vary; occupational identities form; institutional classifications can open or close future possibilities. A snapshot representation can therefore omit causal structure carried by trajectory. Later subsections formalize this point through historical-relational subject representations.

The person also illustrates why dimensions of subjecthood should remain differentiated. Human persons can possess lived experience, moral claims, needs, preferences, capabilities, and forms of vulnerability that are not implied by the fact that another configuration can transact or optimize. GRE's willingness to model organizations, artificial systems, or ecological configurations as economically consequential subjects under specified questions does not place them on a common moral or phenomenological scale. Those further comparisons require independent argument.

12.4.2 Households

Households can function as economic subjects when provisioning, residence, care, pooling, saving, consumption, inheritance, risk sharing, or interdependent decision-making is organized at a household level. Statistical systems also frequently use households and institutional units as basic units of economic description, although the specific definitions vary by purpose (European Commission et al. 2009). For GRE, household subjecthood is therefore neither merely statistical nor automatically substantive. It is reconstructed from the relations that make household-level coordination economically consequential for the question being studied.

Households often combine several mechanisms that are analytically distinct: shared residence, kinship, care, income pooling, joint consumption, authority, dependency, reciprocal obligation, emotional attachment, legal status, and intergenerational transfer. These mechanisms need not coincide. A household can contain several earners who control resources separately; people can share care obligations without co-residence; members can depend on resources controlled by others; migration can distribute a household across jurisdictions; digital and financial infrastructures can sustain collective provisioning across distance. Treating the

household as a single subject can therefore be useful at one resolution and misleading at another.

Internal heterogeneity deserves particular attention. A household-level budget or consumption measure can conceal differences in access, time use, bargaining position, exposure, or sacrifice among members. The analyst should therefore distinguish claims about the household as a coordinating configuration from claims about the persons within it. Household subjecthood can be valid for studying joint constraints or collective provisioning while individual-level subjecthood remains necessary for questions concerning welfare, autonomy, burden, or unequal internal allocation.

The household also illustrates nested subjecthood. A person can be a subject within a household; the household can be a subject within credit, housing, tax, welfare, or community relations; and several households can participate in larger kinship, neighborhood, or commons arrangements. GRE therefore permits multiple levels of subject representation where the relations among levels remain explicit.

12.4.3 Organizations

Organizations can become economic subjects when coordinated structures allow them to hold resources, form plans, enter agreements, allocate tasks, maintain records, learn, represent members, incur obligations, or act through authorized roles. Economic and legal traditions have long recognized that firms and other organizations cannot always be analyzed adequately as momentary aggregates of individual transactions. Coase's classic analysis of the firm addressed the coexistence of organizational coordination and market exchange, while organizational law can stabilize entities through asset partitioning and standardized legal capacities (Coase 1937; Hansmann and Kraakman 2000).

GRE treats organizational subjecthood as historically produced through coordination, role differentiation, authority, memory, resources, boundaries, and external recognition. An organization can persist through turnover of members because records, routines, assets, contracts, names, governance structures, technical systems, and external expectations reproduce some continuity. This persistence can justify treating the organization as a subject for questions concerning investment, liability, strategy, production, bargaining, learning, or institutional interaction.

Organizational subjecthood remains internally structured. A statement such as "the firm decided" can summarize a process involving boards, managers, employees, advisers, shareholders, algorithms, contractual constraints, legal duties, and inherited routines. The summary may be appropriate at one analytical scale, but it should not erase the decision architecture when responsibility, conflict, agency, or distribution within the organization matters. The same applies to universities, cooperatives, associations, charities, unions, foundations, and other organized formations.

Organizations can also exhibit partial or contested subjecthood. A loosely coordinated network may act collectively in some settings while lacking durable centralized representation. A project consortium may hold joint commitments for a limited period. A decentralized digital organization may distribute decision rights across code, token holders, developers, and service providers. GRE does not require a single organizational essence. It asks which mechanisms stabilize collective capacity sufficiently for the organization to become a meaningful economic subject under the selected problem.

12.4.4 Communities

Communities can become economically consequential subjects where shared membership, place, practice, identity, reciprocity, stewardship, knowledge, or governance supports collective capacities that cannot be represented adequately through isolated individuals alone. Commons research is particularly relevant because it demonstrates that groups can develop durable rules for managing shared resources under conditions that differ from both centralized administration and simple market exchange (Ostrom 1990; Ostrom 2005).

Community subjecthood is often less sharply bounded than organizational subjecthood. Membership can be layered, customary, contested, seasonal, geographically dispersed, or based on practice rather than formal registration. Authority can be distributed across elders, committees, norms, reputational structures, technical expertise, or repeated participation. Collective action can emerge without a single permanent representative. These features do not make communities economically irrelevant; they make the terms of subject attribution more dependent on the specific mechanism being studied.

A community can be treated as an economic subject for questions concerning stewardship, shared infrastructure, mutual aid, collective bargaining, cultural production, local development, knowledge preservation, or distribution of common resources. Yet the same community may contain unequal positions, conflicting interests, and internal exclusions. Collective subjecthood should therefore remain compatible with analysis of internal differentiation.

The temporal dimension is also important. Communities can retain memory and obligations across generations even when particular members change. They can also fragment, merge, reconstitute boundaries, or lose the practical conditions that sustained collective action. GRE therefore treats community subjecthood as a historical configuration whose continuity and capacity require empirical reconstruction.

12.4.5 Institutions

Institutions require a more cautious treatment because an institution is not automatically a unified actor. Institutions can be understood as systems of rules, norms, expectations, classifications, procedures, and enforcement arrangements that structure interaction. North's institutional analysis emphasizes humanly devised constraints that shape incentives and economic performance (North 1990). Such structures can be causally powerful without possessing a centralized capacity to decide or act in the same sense as a person or organization.

GRE therefore distinguishes institutional efficacy from institutional subjecthood. A property regime, accounting standard, professional norm, monetary convention, or classification system can alter economic possibilities while lacking a single center of agency. For many questions it is more precise to treat such an institution as relational infrastructure. Later Section 322 develops that architecture directly.

Institution-like formations can nevertheless enter subject positions under certain analytical constructions. A court system, central bank regime, regulatory framework, or university system may be represented as a subject when the inquiry concerns coordinated institutional response, provided that the mechanisms of representation and action are specified. Often the acting subject is an organization or authorized office

embedded within a wider institution. The distinction matters because attributing agency to “the institution” can obscure which bodies interpret rules, exercise discretion, bear responsibility, or possess resources.

Institutional subjecthood is therefore highly scope-dependent. GRE permits shorthand when it improves analysis, but the shorthand should remain decomposable. Where causality, responsibility, conflict, or transformation depends on internal structure, the analyst should return from the institutional label to the organizations, roles, rules, practices, and relations through which institutional effects are produced.

12.4.6 Public Authorities

Public authorities occupy distinctive economic subject positions because they can combine organizational capacities with legally constituted powers over taxation, expenditure, regulation, adjudication, licensing, monetary arrangements, public infrastructure, social provision, procurement, or recognition. These capacities can alter economic fields at scales unavailable to many private actors. Their subjecthood therefore cannot be reconstructed solely from resource holdings or preferences; it also depends on jurisdiction, public mandate, procedural authority, and institutional location.

The category is heterogeneous. A ministry, municipality, court, regulator, central bank, public corporation, school district, or transnational public body can possess different mandates, decision structures, territorial scopes, and forms of accountability. “The state” or “government” can be useful aggregate terms, yet many economic processes depend on differentiation among agencies and levels of authority. GRE therefore treats public-authority subjecthood as layered and institutionally specified.

Public authorities can also act simultaneously through several relational modes. They may transact as purchasers, regulate as rule makers, redistribute through taxation and transfers, provide services, certify statuses, collect information, enforce obligations, finance infrastructure, or coordinate emergency responses. These roles can interact. A procurement rule can reorganize a market; a statistical category can influence eligibility; an infrastructure investment can change spatial economic relations; a legal recognition can create assets or obligations. Subject reconstruction should therefore identify which public capacity is active in the mechanism under study.

Public authority also sharpens the relation between capacity and responsibility. Extensive capacity to alter others’ options can generate corresponding questions of authorization, procedural justification, review, and accountability. Those normative and political questions belong partly to later chapters and neighboring GR domains. Chapter 12 limits itself to reconstructing the subject position through which public authority becomes economically consequential.

12.4.7 Artificial Agents

Artificial systems can occupy economically consequential subject positions when they perform actions that enter transactions, allocation, production, coordination, information processing, recommendation, pricing, contracting workflows, or other economic processes. The relevant systems range from simple rule-based automation to adaptive models and multi-agent computational systems. GRE uses the term *artificial agent* functionally in this section. It indicates a system to which a bounded action role

is attributed within an economic process; it does not establish consciousness, moral status, legal personality, or independent responsibility.

The distinction between delegated action and autonomous practical standing is central. An algorithm can submit orders, adjust prices, route tasks, screen applications, recommend loans, or allocate computational resources. These actions can affect later economic states. Yet the surrounding architecture can include designers, data producers, model owners, deployers, platform operators, regulators, users, and organizations that determine objectives, permissions, infrastructure, monitoring, and consequences. Treating the artificial system as a subject can simplify the causal model while leaving responsibility located elsewhere.

Artificial subjecthood can also be distributed. A model may generate a recommendation, an automated rule may convert the recommendation into an action, an organization may define thresholds, and a human operator may retain override authority. In such cases, a single “AI decision maker” representation can obscure the composite structure. Chapter 11’s treatment of machine-mediated decision support and responsibility distribution therefore remains relevant: economically consequential artificial action should be mapped together with the human and institutional relations that authorize and condition it.

Artificial agents also have histories. Their parameters, software versions, training data, permissions, interfaces, objectives, and institutional roles can change. A system represented as the same named agent across time may therefore embody materially different capacities. Historical-relational representation becomes important when earlier outputs affect later data, later model revisions, organizational reliance, or expectations. Chapter 18 will examine radical human–AI capability asymmetry substantively; the present section establishes only the architectural status needed for Chapter 12.

Caution 12.12 (Functional artificial subjecthood). Attributing economic subjecthood to an artificial system can be useful for tracing economically consequential action. The attribution should state which capacities are delegated to the system, which permissions and constraints are externally supplied, and where responsibility remains located. Functional agency does not by itself establish experience, moral standing, legal personhood, or independent accountability.

12.4.8 Non-Human Participants

Economic processes depend on many non-human participants whose effects cannot always be represented adequately as passive resource stocks. Soil systems, forests, watersheds, animal populations, pathogens, climate processes, energy systems, and other ecological or material configurations can alter production possibilities, labor conditions, infrastructure viability, health, settlement, risk, and the reproduction of economic activity. Ecological economics has long emphasized relationships between ecological and economic systems, while social-ecological analysis treats resource systems, users, governance arrangements, interactions, and outcomes as mutually connected components (Costanza 1989; Ostrom 2009).

GRE uses *participant* here more broadly than intentional agent. A river can condition transport and settlement without choosing to do so. A crop disease can reorganize prices and labor demand without possessing economic intention. An animal can participate in production, care, companionship, or ecological processes while ques-

tions of sentience and welfare introduce dimensions absent from non-sentient systems. These differences should remain visible.

The inclusion of non-human participants serves two analytical purposes. First, it prevents economic architecture from being reconstructed as exclusively interpersonal when material and ecological processes help generate the feasible field. Second, it discourages a simple resource ontology in which every non-human component is represented only through ownership, price, or extractive usefulness. Some non-human configurations have dynamics, thresholds, dependencies, and regenerative conditions that materially constrain economic histories.

Subject terminology should nevertheless be used carefully. In some inquiries, “non-human participant” will be more precise than “economic subject.” In others, especially where the analysis concerns stewardship, legal representation, animal welfare, ecosystem rights, or delegated guardianship, a subject-like representation may clarify which claims or interests are institutionally represented. GRE does not settle these legal, ethical, or metaphysical questions in Chapter 12. It identifies the point at which the choice of representation becomes economically consequential and requires explicit justification.

12.4.9 Heterogeneous Subjecthood

The preceding subsections imply that economic subjecthood is heterogeneous across at least three levels. The first concerns constitution: persons, households, organizations, communities, institutions, public authorities, artificial systems, and non-human participants are stabilized through different combinations of embodiment, recognition, rules, memory, representation, material continuity, and coordinated practice. The second concerns capacity: they possess different abilities to perceive, decide, act, learn, refuse, authorize, bear loss, or mobilize resources. The third concerns normative and legal standing: the fact that two configurations can affect economic outcomes does not imply equal rights, duties, welfare relevance, responsibility, or moral status.

A heterogeneous framework is preferable to an abstract subject category that silently imports the properties of one subject form into all others. Modeling a firm as maximizing an objective can be useful without implying that it experiences welfare. Treating a household as a decision unit can aid analysis without implying homogeneous preferences. Treating an algorithm as an acting node can aid causal reconstruction without transferring responsibility to software. Treating an ecosystem as economically consequential can correct anthropocentric omission without settling whether the ecosystem possesses independent moral standing.

Heterogeneity also appears within subject classes. Persons differ in capacities, histories, institutional statuses, and dependencies. Organizations differ in governance and purpose. Households differ in membership and internal allocation. Public authorities differ in mandate. Artificial systems differ in autonomy and opacity. Non-human participants differ in sentience, dynamics, substitutability, and ecological role. Economic subjecthood therefore should be indexed to the dimensions that matter for the question rather than assigned through a single binary test.

This approach allows strong comparison where warranted. Two firms can be compared with respect to liquidity or market access. A person and a household can be compared with respect to exposure to an energy-price shock. A human trader and an

automated trader can be compared with respect to order-submission speed. Those comparisons remain dimension-specific. GRE resists extending them into global equivalence unless the relevant dimensions have been independently justified.

12.4.10 Conditions of Subject Comparability

Comparability among economic subjects depends on a declared comparison dimension, a compatible scale, and a defensible mapping between the properties being compared. Subject comparability is therefore local to an analytical purpose. A common monetary unit can make expenditures comparable while leaving welfare, need, control, and dependency incomparable. A common legal category can make entities formally comparable while their internal governance differs substantially. A common network metric can compare centrality while saying little about the meaning or legitimacy of the ties that generate that centrality.

At least five conditions deserve attention when heterogeneous subjects are compared. The first is semantic compatibility: the measured property should mean sufficiently similar things across the compared subjects. The second is causal relevance: differences in the property should matter for the mechanism under study. The third is scale compatibility: aggregation or disaggregation should not remove the structure that carries the effect. The fourth is temporal compatibility: measurements should refer to histories or states that can reasonably be compared. The fifth is normative restraint: descriptive comparability should not be converted automatically into equivalence of moral standing or entitlement.

Failure of one condition does not necessarily make comparison impossible. It can require a more qualified representation. For example, organizations and persons can both hold monetary assets, but the consequences of an identical asset loss may differ because their obligations, replacement capacities, legal protections, and welfare implications differ. Artificial and human agents can both produce forecasts, but the evaluation of error may differ because responsibility, interpretability, and experiential consequence are distributed differently. A community and a corporation can both control land, yet the historical and normative meaning of control may differ.

Proposition 12.13 (Dimension-specific comparability). *Within GRE, heterogeneous economic subjects may be compared where the inquiry specifies a common analytical dimension and establishes adequate semantic, causal, scalar, and temporal compatibility. Such comparability does not entail equivalence across dimensions that have not been included in the comparison.*

Proposition 12.13 provides a discipline for later chapters. It permits quantitative and formal comparison without requiring the book to flatten persons, organizations, institutions, artificial systems, and non-human participants into one universal agent type.

12.4.11 Historical-Relational Subject Representations

A subject representation should preserve enough history and relational structure to explain the capacities and constraints relevant to the inquiry. Static vectors of attributes can remain useful when the current state is sufficient for the problem. GRE adds historical-relational representations when present possibilities depend materi-

ally on event order, accumulated relations, prior classifications, institutional trajectories, or path-dependent commitments.

For a person, relevant history might include education, employment, migration, debt, care responsibilities, health events, legal statuses, network changes, or earlier institutional decisions. For an organization, it might include founding arrangements, acquisitions, routines, investments, liabilities, technical systems, changes in governance, and prior commitments. For an artificial agent, it might include model versions, training or update events, permissions, deployment settings, observed failures, and changes in organizational reliance. For a community, it might include membership transformations, stewardship practices, institutional recognition, conflict, and collective memory.

Historical-relational representation is especially important when two subjects with similar present observables possess different future option sets. Equal current income does not imply equal debt exposure, family obligation, skill trajectory, legal security, or access to credit. Equal organizational revenue does not imply equal contractual commitments, infrastructure dependence, technological capability, or institutional support. Equal model performance at one test point does not imply equal training histories or failure modes. The history can therefore alter the practical meaning of the present state.

A useful representation need not contain the entire past. The problem is selective reconstruction. The analyst identifies events and relations that have plausible relevance to the mechanism under study, documents the basis for that selection, and remains open to revision when omitted history becomes consequential. This follows the broader GRE principle that analytical objects are constructed under a question and remain answerable to evidence.

Historical-relational subjecthood also permits identity to be partly continuous and partly transformed. A household can remain identifiable after membership change; an organization can survive a merger while changing governance; an artificial system can retain a product name after substantial model replacement. GRE therefore treats continuity as a relation among histories, functions, recognition, memory, and causal structure rather than assuming immutable identity.

12.4.12 Optional 2-Complex Representation of Subject Histories

A labeled 2-complex can provide one optional formal representation when subject history involves partially ordered events, relations among events, and higher-order structures that cannot be represented adequately by a single linear sequence. The representation is motivated by the event-historical commitments developed earlier in the book. It is a computational and conceptual device, not a claim that subjects are literally 2-complexes or that every economic inquiry benefits from such a formalism.

For a subject s , let a finite labeled event complex be represented by Equation 12.1.

$$\mathcal{K}_s = (V_s, E_s, F_s, \preceq_s, \lambda_s). \quad (12.1)$$

Here V_s is a set of selected events in the reconstructed history of subject s ; E_s contains selected relational links among those events; F_s contains higher-order cells used when a relation among several events or relations must be represented jointly; $\preceq_s$ is a partial order encoding the event-order relations justified by the inquiry; and λ_s as-

signs labels or attributes relevant to the economic problem. The labels can record, for example, institutional status, resource position, contractual role, observed state, decision type, or evidential provenance.

The partial order carries a specific analytical role. It permits some events to be ordered where dependence or precedence matters while leaving unrelated or insufficiently ordered events incomparable. A person can receive a credential before entering an occupation, an organization can acquire an asset before pledging it as collateral, or an artificial system can be updated before a later decision episode. Other events may occur on separate branches whose exact global ordering is irrelevant. The formalism therefore avoids forcing every subject history into a single scalar timeline when the empirical structure supports only partial ordering.

The 2-cells have a different role. They can represent higher-order historical structure in which several links jointly constitute an economically relevant episode. A financing arrangement may join borrower, lender, collateral, guarantor, and legal recognition. A household decision can involve several members and shared constraints. An organizational reconfiguration can connect a policy change, a technical system, and multiple roles. In problems where pairwise links are sufficient, F_s can be omitted and a simpler graph or event sequence should be preferred. Formal complexity should follow analytical need.

A subject state at a selected analytical cut can then be reconstructed from the portion of $\mathcal{K}_s$ lying in its relevant causal or historical past together with current relations to other subjects and infrastructures. GRE does not require that such a state be compressed into one vector. Different models can project the same historical complex into different task-specific state descriptions. A credit model, labor-capacity analysis, welfare inquiry, and organizational-risk model can therefore use different projections while preserving a common provenance structure.

The representation also clarifies how epistemic events can become part of subject history. A classification, diagnosis, rating, credential, legal judgment, model output, or institutional recognition can enter V_s when it changes later options, relations, or representations. The same event may be both epistemic and practically generative. This links Chapter 12 to the epistemic-event architecture developed earlier without requiring every observation to be treated as intervention.

Remark 12.14 (Formal representation and subject pluralism). The event-complex representation is one optional model among many. Attribute vectors, trajectories, networks, process models, qualitative histories, institutional case reconstructions, agent-based representations, or other formalisms may be more appropriate for particular questions. Choice of representation should follow the empirical structure and analytical objective, and results should not be generalized beyond the scope supported by that representation.

Remark 12.14 closes the section by returning to the central discipline of economic subjecthood. GRE can broaden the range of configurations treated as economically consequential subjects while preserving differences in agency, experience, responsibility, recognition, historical constitution, and normative standing. The next task is to distinguish subjecthood from entityhood. Section 315 develops economic entities as stabilized configurations and asks when a configuration can be treated as an identifiable economic entity across changing internal and external relations.

12.5 Economic Entities as Stabilized Configurations

Section 12.4 developed economic subjecthood in terms of heterogeneous capacities for participation, action, representation, exposure, responsibility, experience, and historical continuity. The present section separates that problem from *entityhood*. Its role is to specify when an economically relevant configuration can be treated as sufficiently stabilized and trackable to function as an analytical entity, even where it lacks unified agency or subject status. The objective is therefore modest: to provide a relational and historically revisable account of entity formation, persistence, boundaries, internal structure, external relations, transformation, dissolution, multiple realization, scale, and event history. The argument is conceptual and institutionally informed. It uses legal, accounting, organizational, and relational examples to show that entityhood can be practically real without requiring immutable substance or one universal criterion of identity.

Within GRE, stabilization refers to the maintenance or reproduction of enough structure for a configuration to be identified across a selected range of events. What counts as “enough” depends on the inquiry. A corporation can remain an identifiable entity while employees, owners, contracts, technologies, and assets change. A household can persist through changes in membership. A market platform can retain continuity across software versions and governance reforms. A fund, project, network, infrastructure system, or administrative unit can become economically trackable even when its legal, functional, and relational boundaries do not coincide. Entity attribution therefore requires explicit criteria of continuity and resolution.

Definition 12.15 (Economic entity). For the purposes of GRE, an *economic entity* is a configuration that an inquiry treats as sufficiently stabilized, differentiated, and historically trackable for the economic mechanism under analysis. Entityhood is attributed relative to specified continuity criteria, boundaries, scale, and evidential purpose; it does not by itself imply subjecthood, agency, legal personality, moral standing, or ontological fundamentality.

Definition 12.15 gives entityhood an analytical role without reducing it to arbitrary labeling. Stabilization can be produced by contracts, organizational routines, material continuity, legal recognition, accounting practice, technical architecture, repeated interaction, collective identification, or combinations of these mechanisms. Some configurations are stabilized strongly enough that many independent practices recognize approximately the same entity. Others remain provisional, contested, or highly dependent on the resolution of the inquiry.

Table 12.7 summarizes the principal dimensions developed in this section. The dimensions provide diagnostic prompts for entity attribution. Different research questions can justifiably privilege different subsets and forms of continuity, so the table does not function as a universal constitutive test.

12.5.1 Entity Formation

Entity formation is the process through which a configuration becomes sufficiently differentiated and reproducible to support stable reference in an economic inquiry. Formation can be explicit, as when an organization is legally incorporated, a fund is constituted, a cooperative adopts governing rules, or a project vehicle is contractually created. It can also be gradual. Repeated exchange, shared infrastructure, co-

Table 12.7: Selected dimensions of economic entityhood and corresponding analytical questions.

Dimension	Analytical question	Illustrative sources of stabilization
Formation	Through which processes does a configuration become separately trackable?	Legal creation, repeated coordination, material assembly, contractual linkage, institutional recognition
Persistence	Which continuities support identification through change?	Rules, memory, ownership structure, routines, infrastructure, recognition, recurring relations
Boundary	Which distinctions separate inside, outside, member, asset, obligation, or activity?	Law, accounting, governance, technology, function, spatial organization, relational practice
Internal structure	Which differentiated components and relations reproduce the configuration?	Roles, hierarchy, modularity, workflows, shared resources, communication, technical sub-systems
External relations	Which relations sustain, constrain, or transform the entity from outside its selected boundary?	Exchange, regulation, finance, supply, care, knowledge, infrastructure, network position
Transformation	Which changes preserve continuity and which create a successor or different entity?	Merger, reorganization, conversion, migration, recapitalization, technological replacement
Dissolution	Through which processes does trackable continuity cease?	Liquidation, fragmentation, abandonment, legal termination, functional collapse, relational dispersal
Scale	At which analytical resolution does the configuration function as one entity?	Person, household, organization, consortium, sector, platform ecosystem, infrastructure system
Event history	Which ordered events establish the entity's continuity, discontinuity, or reconstitution?	Founding, recognition, acquisition, split, default, redesign, succession, termination

ordinated practice, or common dependence can stabilize a configuration before any formal act declares that a new entity exists.

Legal and organizational research provides clear examples of explicit stabilization. Organizational law can create standardized legal persons, allocate ownership and governance rights, and partition organizational assets from the personal assets of owners or managers (Hansmann and Kraakman 2000). These arrangements can make an entity easier to identify across transactions because rights, liabilities, and decision authority become attached to a recognized organizational unit. The legal

act matters economically because counterparties, creditors, regulators, workers, and courts can coordinate around the resulting status.

Legal constitution is nevertheless one mechanism among several. Coase's analysis of the firm frames organizational formation partly through the coordination of transactions under an authority relation where using the price mechanism carries costs (Coase 1937). Network forms can stabilize collaboration without reproducing the same hierarchical or ownership structure. Communities can organize shared resources without becoming corporations. Technical infrastructures can acquire durable operational boundaries through standards and interoperability. GRE therefore treats formation as a mechanism-specific process and keeps incorporation as one important route among several.

Formation can also be retrospective. Researchers, accountants, regulators, communities, or participants may recognize that a relatively coherent configuration has emerged only after repeated events reveal continuity. Such recognition can then strengthen the entity by naming it, measuring it, assigning rights or obligations to it, or designing institutions around it. Recognition and formation can therefore interact recursively: stabilization makes identification possible, while identification can become one mechanism of further stabilization.

A formation account should specify at least the configuration being differentiated, the relations that reproduce it, the events through which continuity became observable, and the practices through which participants or observers began to treat it as one unit. These requirements help distinguish empirically grounded entity attribution from convenient reification.

12.5.2 Entity Persistence

Entity persistence concerns continuity through change. The economically important question is rarely whether every component remains identical. Many entities persist precisely because components can be replaced while selected structures, functions, obligations, recognition relations, or historical linkages continue. An organization can survive personnel turnover; a household can survive changes in residence or membership; an infrastructure can survive component replacement; a digital service can survive substantial code revision.

Persistence therefore requires a stated continuity criterion. Different inquiries can use different criteria without contradiction. A legal inquiry may track charter, registration, or succession. An accounting inquiry may track control over a reporting boundary. A production inquiry may emphasize continuity of coordinated activity. A labor inquiry may emphasize employment relations. A community inquiry may emphasize shared membership practices or memory. A technological inquiry may emphasize service continuity or interface compatibility.

The existence of several defensible criteria makes entity identity potentially contestable. A corporation after a merger can be continuous for contractual purposes while discontinuous for organizational culture. A household can remain one administrative unit while its care relations have been substantially reorganized. A platform can keep the same commercial name while replacing its technical architecture, governance, and participant base. GRE therefore asks which dimension and mechanism of persistence is relevant to the inquiry and how strongly the available evidence supports continuity along that dimension.

Proposition 12.16 (Dimension-relative persistence). *An economic entity may persist across change when the continuity relations relevant to the inquiry remain sufficiently supported. Persistence along one dimension does not establish continuity along dimensions whose stabilizing relations have been substantially transformed.*

Proposition 12.16 supports both precision and revisability. It allows a study to use stable entity identifiers where justified while preserving the possibility that identity must be decomposed when internal transformation matters for causal explanation, responsibility, distribution, or historical interpretation.

12.5.3 Entity Boundaries

Entity boundaries specify which components, activities, rights, obligations, resources, or relations are treated as internal to an entity for a given purpose. Boundaries can be legal, accounting, organizational, technological, functional, spatial, or relational. Their overlap is an empirical matter. A legal entity can contain several operational divisions; a reporting entity can include multiple legal entities; a supply network can coordinate activities across many ownership boundaries; a household can pool some resources while keeping others separate.

The accounting concept of a reporting entity illustrates this scope dependence directly. The IFRS Conceptual Framework permits a reporting entity to be a single entity, a portion of an entity, or more than one entity and does not require the reporting boundary to coincide with a legal entity (IFRS Foundation 2018). This example matters beyond accounting because it demonstrates that economically useful entity boundaries can be constructed according to the information problem while remaining disciplined by explicit inclusion criteria.

Boundaries also perform economic work. Asset partitioning can separate pools of assets and creditor claims; membership rules can determine access to collective resources; technical interfaces can decide which actors can interoperate; platform rules can determine which transactions occur inside a governed environment; jurisdictional boundaries can allocate authority and regulatory responsibility. Boundary analysis therefore concerns both representation and causation.

A GRE analysis should distinguish at least three boundary questions. The first is *descriptive*: which boundary do participants and institutions currently use? The second is *causal*: which boundary actually matters for the mechanism being studied? The third is *analytical*: which boundary permits the inquiry to retain the relevant relations without unnecessary complexity? These boundaries can coincide, but the framework does not presume that they do.

Remark 12.17 (Boundary plurality). Multiple boundaries can be simultaneously valid for different tasks. Their coexistence becomes analytically consequential when conclusions depend on which boundary is selected, especially where costs, benefits, liabilities, risks, capacities, or responsibilities cross the selected perimeter.

Remark 12.17 anticipates later treatment of membership, access, ownership, platforms, and internal–external coupling. Boundary selection therefore forms part of economic explanation and can materially affect the conclusions produced by an analysis.

12.5.4 Internal Structure

Treating a configuration as one entity does not erase its internal structure. Economic entities can contain roles, departments, assets, routines, technical modules, decision rights, internal markets, shared resources, informal relations, and differentiated capacities. These structures often explain how the entity reproduces itself and how external events propagate through it.

Simon describes hierarchy and near decomposability as possible features of complex systems that can support relative stability across levels (Simon 1962). GRE uses this as a representational resource whose applicability depends on the organization under study. Some entities have strongly modular structures; others are densely coupled, fluid, or difficult to partition. The degree of decomposability is therefore an empirical property.

Internal structure matters whenever aggregate entity-level variables conceal consequential differentiation. A firm can report positive profits while particular units contract. A household can appear solvent while one member bears disproportionate unpaid care. A public authority can appear coherent while agencies pursue conflicting mandates. A platform can function as one commercial service while control over data, models, infrastructure, and governance is distributed across several organizations.

Accordingly, entity-level explanation should remain decomposable. The analyst can work at the entity scale when aggregate behavior is adequate to the question and return to internal relations when coordination, conflict, responsibility, vulnerability, or transformation depends on lower-level structure. This movement across levels prevents analytical convenience from becoming an assumption of internal homogeneity.

12.5.5 External Relations

Entityhood is also sustained through relations that cross its selected boundary. Suppliers, customers, creditors, regulators, infrastructures, communities, ecological systems, knowledge networks, and public institutions can contribute materially to the capacities that appear at the entity level. Granovetter's analysis of embeddedness provides one influential economic-sociological precedent for treating economic action as situated in ongoing social relations (Granovetter 1985).

The distinction between internal and external relations is therefore analytical. Externality to the selected boundary remains compatible with strong causal dependence. A firm may depend on public infrastructure, external finance, standards, professional knowledge, labor markets, and long-term supplier relations. A household can depend on schools, care services, transport, housing markets, kin networks, and welfare institutions. A digital service can depend on cloud infrastructure, data pipelines, application interfaces, device ecosystems, and legal permissions.

External relations can stabilize entityhood by supplying recurring inputs, recognition, legitimacy, finance, demand, information, or coordination. They can also destabilize it through withdrawal, conflict, regulatory change, infrastructure failure, technological substitution, or altered expectations. Entity analysis should therefore record the relational environment required for persistence when that environment is causally significant.

This point places a limit on self-contained entity explanations. An entity can be

treated as a unit without being treated as causally closed. GRE uses entity abstraction to manage analytical complexity while retaining the option to reopen the boundary whenever cross-boundary relations materially affect the phenomenon under study.

12.5.6 Entity Transformation

Entity transformation occurs when internal structure, boundary, recognition, function, or external relations change while some continuity remains. Transformation can be incremental, such as changes in membership or technology, or discontinuous, such as merger, conversion of legal form, large-scale restructuring, platform migration, or institutional redesign. The analytical problem is to determine which continuities survive and which mechanisms have been replaced.

A transformation can preserve a label while altering the configuration that gives the label economic meaning. Conversely, labels can change while much of the operative configuration persists. This is one reason GRE separates manifestation and recognition from relational reality. Names, registrations, accounting identifiers, and brands can provide valuable traces of continuity, yet they should be interpreted together with the relations that reproduce the entity.

Transformation also changes the relevance of historical evidence. Performance measured under a previous organizational structure may transport poorly after a merger or technological redesign. Risk estimates based on earlier dependencies may become stale when suppliers or infrastructures change. Responsibility assignments may require reconstruction when decision rights are redistributed. Entity transformation is therefore both an object of description and a change in the epistemic conditions under which the entity can be analyzed.

For longitudinal work, the researcher should document transformation events and state whether continuity is being assumed, tested, or restricted to selected dimensions. This practice makes later claims about trends, persistence, or causal effects more transparent.

12.5.7 Entity Dissolution

Entity dissolution is the loss of sufficient continuity for a configuration to remain usefully trackable as the same economic entity under the selected criteria. Dissolution can occur through legal termination, liquidation, fragmentation, absorption into another organization, abandonment, technical collapse, dispersal of membership, or erosion of the relations that previously reproduced the entity.

Different forms of dissolution need not coincide in time. A corporation can cease operations before legal liquidation is complete. An organization can retain legal personality after losing most of its operational capacity. A community can lose institutional recognition while social relations persist. A platform can shut down a service while contracts, data obligations, creditor claims, or user dependencies remain. Dissolution therefore often has an afterlife.

Residual relations are particularly important economically. Liabilities, warranties, archives, intellectual property, environmental obligations, pensions, debts, data-retention duties, reputational effects, and infrastructural dependencies can survive the entity configuration that generated them. A dissolution analysis that stops at formal termination can therefore miss economically consequential continuities.

GRE treats dissolution as an event-historical process whose consequences can extend beyond the end of entity-level coordination. This mirrors the treatment of exit in application-dominant praxis: cessation of one organized configuration does not erase the history through which rights, obligations, dependencies, and effects were produced.

12.5.8 Multiple Realization

Multiple realization concerns the possibility that a recognizable economic role, function, or entity type can be sustained by materially different internal configurations. A payment service can be implemented through different technical architectures. A cooperative can use different governance procedures. A household can organize provision through different combinations of paid work, unpaid care, transfers, and shared resources. A reporting unit can encompass different legal structures while serving a comparable informational role.

The concept is useful when comparative analysis would otherwise confuse function with substrate. If several configurations provide similar services or occupy similar institutional positions, a higher-level entity type can support comparison. The comparison remains qualified because similar function does not imply identical capacities, vulnerabilities, power relations, distributional consequences, or histories.

Multiple realization also operates over time within one entity. An organization can preserve selected functions while replacing technologies, staff, routines, or suppliers. In such cases, persistence and multiple realization intersect: continuity is partly achieved through the capacity to alter lower-level components while maintaining higher-level relations or outputs.

Remark 12.18 (Functional similarity and relational difference). Functional or institutional similarity can justify comparison at a selected level while substantial relational differences remain analytically relevant. Multiple realization therefore supports abstraction only to the degree warranted by the research question.

This remark prevents functional equivalence from becoming a claim of structural or normative equivalence. Later analysis of organizations, markets, platforms, ownership, and coordination will repeatedly require this distinction.

12.5.9 Scale-Relative Entityhood

Entityhood changes with analytical scale. A worker can be treated as one economic entity in a labor-market model and as a historically differentiated subject in a study of skills, care, health, or migration. A firm can be one entity in an industry model and a configuration of divisions, contracts, technologies, workers, and governance relations in an organizational analysis. A supply chain can become one operational entity for resilience analysis even though it contains many legally independent firms.

Scale-relative entityhood is compatible with the multilevel structure of complex systems. Simon's account of near-decomposability illustrates why some subsystems can sometimes be analyzed approximately as units while remaining components of larger structures (Simon 1962). GRE extends this methodological point cautiously: the appropriate entity scale depends on the mechanism, time horizon, and cross-level coupling relevant to the inquiry.

Scale selection can change apparent causal responsibility and distribution. A multinational group treated as one entity can obscure transfers among subsidiaries. A household treated as one unit can obscure intrahousehold inequality. A national economy treated as one system can obscure regional or sectoral asymmetry. Conversely, excessive disaggregation can obscure collective capacity, systemic constraints, network effects, or emergent coordination.

A scale choice should therefore be explicit and revisable. Where conclusions are sensitive to aggregation, the analysis should compare alternative resolutions or state the limits of the chosen scale. This discipline is especially important for later GRE work on multiscale transfer, asymmetry, generative potential, and cross-scale justice.

12.5.10 Event-Historical Entity Structure

An event-historical representation treats entityhood as continuity reconstructed through a sequence or partial order of formation, recognition, transformation, and dissolution events. This perspective complements state-based descriptions. A current entity record can show what exists at a selected date; an event history explains how the present configuration became possible and which continuities support its identification.

Relevant events can include incorporation, acquisition, membership change, licensing, capitalization, contract formation, default, reorganization, infrastructure migration, regulatory recognition, merger, split, succession, or termination. The relevant ordering is problem-dependent. Some events have clear dependence relations, while others can remain only partially ordered. GRE therefore does not require a single universal clock sequence where the empirical problem is better represented through event precedence and branching histories.

The optional event-complex formalism introduced for subject histories in Section 12.4.12 can be adapted to entity histories when higher-order relations among several events are analytically important. A merger, for example, can connect several predecessor entities, contracts, recognition acts, and asset transfers. A platform reorganization can involve technical migration, governance change, contractual revision, and user transition. The present section does not introduce a second formalism because the same representational family can be reused when it earns its place.

Event history also clarifies entity identity after discontinuity. A successor organization can inherit assets, obligations, personnel, records, or legal liabilities without being identical to its predecessor along every dimension. A dissolved entity can remain historically active through outstanding claims or infrastructures. A reconstituted community can recover names and practices while operating under new institutions. These cases are easier to analyze when continuity is represented through specific event and relation pathways that preserve dimension-specific forms of succession and discontinuity.

Remark 12.19 (Entityhood as a revisable analytical commitment). Treating a configuration as an entity is a commitment to a particular level of stabilization, boundary, and historical continuity. The commitment can be revised when new evidence shows that the selected unit conceals relations essential to the question or combines components whose trajectories should be distinguished.

Remark 12.19 completes the separation between subjecthood and entityhood. Economic analysis often requires stable units, yet stability can be reconstructed without

converting those units into timeless substances. The next section turns from identifiable configurations to the relations through which economic entities and subjects become connected. Section 316 develops exchange, production, labor, ownership, credit, care, knowledge, trust, authority, dependency, cooperation, and conflict as heterogeneous economic relations whose effects depend on history, institutional setting, and relational configuration.

12.6 Economic Relations

Sections 12.4 and 12.5 distinguished economic subjects from stabilized economic entities. The present section shifts the analytical emphasis from identifiable configurations to the relations through which economic activity is organized, constrained, reproduced, and transformed. Its role is foundational: to establish a heterogeneous vocabulary of economic relations before later sections examine higher-order relations, relational configurations, institutions, markets, resources, ownership, circulation, labor, dependence, and asymmetry in greater detail. The objective is therefore classificatory and relational rather than exhaustive. Exchange, production, labor, ownership, credit, care, knowledge, trust, authority, dependency, cooperation, and conflict are developed as recurrent relation-forms whose concrete meaning depends on history, institutional setting, scale, and the positions of participating subjects. The discussion combines conceptual reconstruction with selected economic and social-theoretical precedents while preserving GRE's ontological suspension and methodological pluralism.

Economic analysis has often privileged particular relations according to its problem setting: exchange and price relations in market analysis, production and labor relations in classical and Marxian political economy, contractual and authority relations in theories of the firm, institutional relations in institutional economics, and embedded social relations in economic sociology. Smith connected division of labor and exchange to the development of productive powers (Smith 1776); Marx analyzed production through historically specific relations among labor, property, cooperation, and capital (Marx 1867); Coase treated the firm partly through the relation between market coordination and direction within an organization (Coase 1937); and Granovetter emphasized that economic action is embedded in ongoing structures of social relations (Granovetter 1985). These traditions motivate a broad relational vocabulary without establishing that one relation-form provides a complete grammar of economic life.

Definition 12.20 (Economic relation). Within GRE, an *economic relation* is a historically situated connection among subjects, entities, practices, resources, representations, or institutions that materially conditions economic capacities, constraints, transfers, obligations, expectations, participation, or future possibilities within the inquiry under consideration. The attribution of an economic relation is analytical and evidential: its form, direction, scale, duration, and boundaries should be specified relative to the mechanism being studied.

Definition 12.20 gives relations causal and historical content without requiring them to be substances. A relation can be formal or informal, episodic or durable, direct or mediated, reciprocal or asymmetric, voluntary or constrained, recognized or weakly institutionalized. It can also change form. A short-term exchange can become

a repeated credit relationship; collaboration can generate authority or dependency; care can become contractual labor; knowledge exchange can create intellectual property claims; conflict can produce a negotiated institution. GRE therefore treats relation-form as a revisable analytical description of a changing configuration.

The relation-forms developed below are also non-exclusive. One employment relation can simultaneously contain exchange of labor for remuneration, organizational authority, knowledge transfer, trust, dependency, cooperation, and conflict. A credit relation can combine ownership claims, legal authority, expectations, information asymmetry, and dependence on future income. Table 12.8 summarizes the selected forms and the principal analytical questions they introduce. The table functions as a vocabulary for inquiry rather than a completed taxonomy.

Proposition 12.21 (Multi-relational composition). *An empirically observed economic connection can instantiate several relation-forms simultaneously, and its consequences can depend on interactions among those forms. Analytical separation is therefore useful for diagnosis, while explanation may require reconstruction of their composition.*

Proposition 12.21 prevents the vocabulary from becoming a rigid classification system. It also prepares the later move to higher-order relations and relational configurations. The remainder of this section introduces each relation-form at a level sufficient for later synthesis while leaving its detailed institutional and normative development to subsequent sections and chapters.

12.6.1 Exchange

Exchange refers to a relation in which parties condition transfers, performances, permissions, or claims upon one another. Market purchase is an important instance, yet exchange also occurs through barter, negotiated service, reciprocal provision, platform-mediated transactions, informal arrangements, and institutionally regulated transfers. Polanyi's account of the economy as an instituted process distinguishes exchange from reciprocity and redistribution and emphasizes that forms of integration depend on institutional organization (Polanyi 1957). GRE therefore treats exchange as one economic relation-form among several rather than as the universal template through which every economic connection should be interpreted.

An exchange analysis should identify what is transferred, how the relevant objects or performances are recognized, how terms are formed, which parties possess bargaining capacity, which temporal sequence governs performance, and which institutions stabilize expectations. Monetary price can summarize part of the relation while leaving other dimensions unresolved. Contractual rights, search costs, quality uncertainty, social reputation, legal enforceability, platform rules, or repeated interaction can materially shape the feasible terms of exchange.

Exchange also carries history. Repeated transactions can create reputation, dependence, relational-specific investment, learned expectations, or informal obligations. A formally identical transaction can therefore have different practical significance for a new entrant and a long-term counterpart. The relation may further generate external connections to finance, regulation, infrastructure, or social networks. Granovetter's embeddedness argument is relevant here because observed market transactions can depend on continuing social relations that cannot be reconstructed from price and quantity alone (Granovetter 1985).

GRE accordingly treats exchange as a relational event within a wider configura-

Table 12.8: Selected economic relation-forms and associated analytical questions.

Relation-form	Core analytical concern	Selected dimensions
Exchange	Reciprocal or conditional transfer among differently positioned parties	Object of transfer, valuation, timing, bargaining, reciprocity, institutional setting
Production	Joint transformation of materials, information, capabilities, or services	Inputs, coordination, technology, task structure, residuals, control
Labor	Participation through work, effort, skill, time, or task performance	Remuneration, authority, autonomy, protection, skill formation, recognition
Ownership	Institutionally recognized claims over use, benefit, exclusion, transfer, or control	Claim bundle, legal form, effective control, beneficiaries, obligations
Credit	Present transfer or capacity conditioned by expectations concerning future performance	Time, repayment, collateral, interest, information, enforcement, default
Care	Provision oriented toward maintenance, development, or support of persons and relationships	Need, dependence, time, reciprocity, obligation, compensation, recognition
Knowledge	Creation, access, communication, use, withholding, and transformation of knowledge	Codifiability, tacitness, access, learning, appropriation, provenance
Trust	Reliance under incomplete control or knowledge of another party's future conduct	Vulnerability, expectation, reputation, institutions, monitoring, breach
Authority	Institutionally or relationally recognized capacity to direct, authorize, constrain, or decide	Scope, legitimacy, hierarchy, delegation, contestability, review
Dependency	Reliance in which another relation, resource, or actor materially conditions feasible action	Alternatives, substitutability, switching costs, asymmetry, duration, exit
Cooperation	Coordinated action toward partially shared or mutually compatible purposes	Contribution, reciprocity, governance, learning, surplus, distribution
Conflict	Incompatibility or contestation over resources, rules, recognition, obligations, or trajectories	Stakes, bargaining, power, escalation, institutional mediation, settlement

tion. Later chapters can formalize prices, allocation, transfer, and value conversion where the problem requires them, but the present architecture keeps visible the parties, institutional conditions, histories, and future relations through which exchange becomes economically consequential.

12.6.2 Production

Production refers to relations through which materials, energy, information, knowledge, services, capabilities, or other economically relevant states are transformed through coordinated activity. The relation-form includes technical transformation but extends to the organization of tasks, access to inputs, coordination among participants, control over productive assets, and the distribution of resulting outputs and residual consequences.

Classical political economy linked production to division of labor and the development of productive powers (Smith 1776). Marx placed production within historically constituted relations among labor, property, cooperation, machinery, and capital (Marx 1867). Contemporary production can additionally involve distributed suppliers, platform infrastructures, automated systems, public research, households, care networks, data pipelines, and transnational value chains. These arrangements make production relationally heterogeneous even when the output is represented as one commodity or service.

For GRE, production analysis therefore asks which transformations occur, which subjects and entities participate, which resources and capacities are mobilized, which authority and knowledge relations coordinate the process, and which consequences are carried beyond the immediate production boundary. Productive capacity can be generated through learning, infrastructure, standardization, or collaboration; it can also be depleted through environmental damage, deskilling, exclusion, dependency, or loss of redundancy. These consequences matter because production can reshape later action spaces rather than merely produce a contemporaneous output.

The relation-form remains scale-sensitive. A household meal, a software project, an industrial plant, a scientific collaboration, and a distributed supply network all involve production, yet their coordination mechanisms and relevant subjects differ substantially. Later sections therefore decompose organizations, infrastructures, resources, capacities, labor, and multiscale architecture rather than treating production as one homogeneous process.

12.6.3 Labor

Labor relations connect work, effort, skill, time, task performance, organizational participation, and the institutions through which these activities are recognized and governed. Wage employment is a central case, but economically consequential labor also occurs in self-employment, cooperative production, family enterprises, unpaid household work, care, volunteering, apprenticeship, platform work, and hybrid arrangements. The boundary between labor and adjacent activities is historically and institutionally contested.

A labor relation can contain remuneration, authority, monitoring, skill formation, occupational identity, legal protection, bargaining, care obligations, and dependency at the same time. The exchange of labor for wages therefore captures only one dimension. Marx's analysis of the labor process emphasizes relations among labor-power, control, cooperation, and production organization (Marx 1867); feminist economics has further shown that economically necessary household and care activities can become obscured when labor is identified primarily with paid employment (Himmelweit 1995; Power 2004).

GRE approaches labor through several questions: who performs which activities, under what authority and contractual conditions; which capacities are exercised or developed; what forms of compensation and protection exist; which dependencies are created; and how participation changes later possibilities for the worker, organization, household, or community. Skill formation can increase future agency while occupational lock-in can narrow alternatives. Stable employment can support planning while concentrated employer dependence can increase vulnerability. These consequences cannot be inferred from wage level alone.

The present subsection provides only the relation-form. A later section on labor and participation develops activity, contribution, paid and unpaid labor, care and knowledge labor, artificial labor, and forms of participation beyond employment in greater detail.

12.6.4 Ownership

Ownership relations organize institutionally recognized claims concerning use, benefit, exclusion, transfer, control, residual income, liability, or succession. Different legal and institutional systems can combine these incidents differently, and effective control can diverge from nominal ownership. GRE therefore treats ownership as a structured relation among claimants, assets, institutions, and affected parties rather than as an intrinsic property residing in an object.

Economic consequences depend on the content and enforcement of claims. Organizational law can separate assets and creditor claims across legal entities, thereby stabilizing economic organization and altering risk allocation (Hansmann and Kraakman 2000). Shared ownership, trusts, cooperatives, public ownership, common-property arrangements, intellectual-property regimes, and platform control illustrate that ownership can distribute rights and responsibilities across several parties. A party can also exercise substantial control without holding conventional title, while a legal owner can face contractual, fiduciary, regulatory, or social constraints on use.

Ownership is historically generative because claim structures shape future access, bargaining, investment, inheritance, exclusion, and control over transformation. Changes in ownership can reorganize relations even where the material object remains unchanged. Conversely, practical use and benefit can change without formal transfer of title. An adequate analysis should therefore specify which incidents of ownership are relevant and distinguish legal recognition from effective relational control.

Later sections examine ownership and control directly. The present role is to place ownership beside other relation-forms so that it is neither treated as the sole foundation of economic structure nor reduced to one binary relation between person and thing.

12.6.5 Credit

Credit relations connect present access to resources or purchasing capacity with expectations concerning future performance. They therefore organize economic relations across time. A borrower receives current capacity subject to future repayment or performance; a lender accepts exposure on the basis of information, collateral, institutional enforcement, reputation, risk assessment, or other expectations. Credit

can support investment, consumption smoothing, innovation, trade, emergency response, and organizational continuity, while also creating durable obligations and dependence.

The economic significance of credit extends beyond the amount transferred. Interest, maturity, collateral, priority, covenants, currency denomination, refinancing conditions, information requirements, and default rules can redistribute future flexibility among parties. Schumpeter treated credit as central to financing new combinations and economic development (Schumpeter 1934). From a GRE perspective, this illustrates how a relation can modify the feasible future of an actor before the productive transformation it supports has occurred.

Credit also depends on representations. Ratings, income records, collateral valuations, histories of repayment, legal identities, and model-generated risk estimates can condition access. These representations may become performative when they alter borrowing terms, investment opportunities, or institutional behavior. The relation therefore joins monetary transfer to knowledge, trust, authority, and legal recognition.

The history of a credit relation can remain consequential after repayment or default through reputation, collateral loss, legal records, organizational restructuring, or changed access to future finance. GRE therefore treats credit as an event-historical relation whose effects can persist beyond the formal duration of the contract.

12.6.6 Care

Care relations concern activities and commitments oriented toward maintaining, supporting, developing, or restoring the capacities and well-being of persons and relationships. They can occur within households, families, communities, markets, public institutions, professional organizations, or mixed arrangements. Care can be paid or unpaid, voluntary or institutionally assigned, reciprocal or strongly asymmetric, episodic or sustained across long periods.

Feminist economics has demonstrated that care and social provisioning can be economically consequential even where conventional accounting or labor categories render them weakly visible (Folbre 1994; Power 2004). Care affects time allocation, labor-market participation, education, health, intergenerational development, household capacity, and the reproduction of future economic subjects. Its analysis therefore cannot be confined to sentimental or private domains when the relevant consequences are economic.

A relational approach also preserves differences among care arrangements. The same nominal service can have different meanings and effects depending on trust, continuity, professional standards, kinship, reciprocity, obligation, and the recipient's dependence. Compensation can change the institutional form of care without eliminating its relational content. Conversely, unpaid status does not establish voluntariness or equitable distribution of responsibility.

GRE treats care as one relation-form that can intersect with labor, authority, dependency, knowledge, and trust. Its normative evaluation remains situated: the existence of a durable care relation does not by itself establish that its distribution of burden, agency, or recognition is desirable. Later analysis of households, communities, labor, access, and allocation can specify these questions more fully.

12.6.7 Knowledge

Knowledge relations concern the creation, possession, communication, withholding, interpretation, validation, and transformation of knowledge among economically situated subjects and institutions. Their importance arises partly from the uneven distribution of information and expertise and partly from the capacity of knowledge to change production, coordination, bargaining, innovation, and future learning.

Hayek emphasized the coordination problem created by dispersed and incomplete knowledge distributed across different persons (Hayek 1945). Arrow's analysis of invention highlighted uncertainty and appropriation difficulties that distinguish information production from ordinary commodity production (Arrow 1962). Knowledge can also function as a shared resource governed through institutions of access, contribution, preservation, and enclosure (Hess and Ostrom 2007). These traditions point to several relation-forms rather than one uniform object called knowledge.

GRE therefore asks who can know what, through which practices and infrastructures, with what reliability, and under which rights of access, use, secrecy, attribution, or exclusion. Tacit knowledge can remain tied to participation and experience; codified knowledge can travel across organizational or geographic boundaries; proprietary knowledge can support bargaining power; open knowledge can enable distributed learning; algorithmic systems can mediate access while introducing new dependencies.

Knowledge relations are generative in a direct sense because they can alter the capacities of participants. Teaching, collaboration, documentation, imitation, and shared problem solving can create capabilities that persist after an immediate transaction ends. Knowledge withholding or enclosure can likewise constrain future participation. The economic consequences therefore concern both present information and the evolution of who can learn, decide, produce, or contest later.

12.6.8 Trust

Trust relations involve reliance on another party, institution, representation, or process under conditions in which complete monitoring or control is unavailable. Trust can reduce the practical burden of verifying every action, facilitate cooperation, support credit, and make repeated exchange possible. It also creates vulnerability because reliance exposes one party to conduct that cannot be fully guaranteed in advance.

Arrow identified trust and related social virtues as economically important to exchange and collective organization (Arrow 1972). Ostrom's behavioral work similarly connects trust, reciprocity, and reputation to the possibility of sustained collective action in settings where short-run individual incentives can undermine cooperation (Ostrom 1998). GRE incorporates these insights while distinguishing trust from simple prediction. A person can predict another's opportunism without trusting them; trust involves a willingness to rely under some degree of exposure.

The sources of trust can differ. Repeated experience, reputation, shared identity, professional norms, legal safeguards, guarantees, transparent procedures, auditing, or technical verification can support reliance in different ways. These sources are not equivalent. Institutionally secured reliance can reduce the need for interpersonal trust, while excessive reliance on personal trust can sometimes substitute for weak

formal protection. Conversely, formal verification can become costly or incomplete enough that relational trust remains economically consequential.

Trust can also be path dependent. Breach may alter future cooperation beyond the immediate loss, while successful coordination can accumulate reputational and relational capital. GRE therefore treats trust as a historically evolving relation that interacts with knowledge, authority, credit, cooperation, and conflict.

12.6.9 Authority

Authority relations concern recognized capacities to direct, authorize, prohibit, allocate, interpret, adjudicate, or decide within a specified domain. Economic authority appears within firms, households, public agencies, professional bodies, platforms, financial institutions, associations, and other organizations. Its scope can be formalized through law or contract, generated through organizational position, or sustained through convention and expertise.

Coase's analysis of the firm draws attention to coordination in which resource allocation can occur through direction rather than repeated market contracting (Coase 1937). Organizational authority, however, is rarely unitary. It can be delegated, divided, reviewed, contested, or conditioned by rules and professional standards. A manager can direct tasks without owning the organization; a platform can set participation rules without owning participant assets; a regulator can constrain conduct without managing production.

GRE analyzes authority through its scope, basis, duration, reviewability, and relation to affected capacities. Authority can enable coordination where distributed negotiation would be costly or slow. It can also produce dependency, information concentration, strategic silence, or self-reinforcing control. These possibilities should be investigated rather than inferred from the presence of hierarchy alone.

Authority can further become historically sticky. Temporary decision rights may become routine, emergency powers may outlast the conditions that justified them, and technical expertise can become institutionalized into durable gatekeeping. Later sections on organizations, institutions, access, control, and asymmetry develop these mechanisms more fully.

12.6.10 Dependency

Dependency relations arise when one actor's feasible actions, capacities, or continuity depend materially on another actor, resource, institution, infrastructure, or relational configuration. Dependence is therefore relative to alternatives. A relationship can be economically important because exit is costly, substitutes are unavailable, switching requires specialized investment, legal status is tied to the relation, or essential knowledge and infrastructure are concentrated elsewhere.

Dependency should be distinguished from simple connection. A supplier can be connected to many buyers without being strongly dependent on any one of them; another supplier can depend heavily on a single buyer even when the monetary flow is modest. Global value-chain research illustrates how coordination forms can differ with transaction complexity, codifiability, supplier capability, and power asymmetry (Gereffi et al. 2005). GRE generalizes the analytical question beyond value chains by

asking which alternatives remain feasible and how the relation changes those alternatives over time.

Dependence can be mutual and still asymmetric. Two organizations can need one another while differing substantially in their capacity to absorb interruption, replace the relationship, finance delay, or influence governing rules. Dependence can also be generated endogenously. Investment in relation-specific assets, learned routines, proprietary standards, accumulated debt, data lock-in, or care obligations can deepen reliance through continued participation.

The normative significance of dependency cannot be read directly from its magnitude. Some durable dependencies support care, specialization, infrastructure, or collective capacity. Others can expose participants to domination, extraction, or severe exit costs. GRE therefore treats dependency as an empirical relational property whose desirability requires additional normative and institutional analysis.

12.6.11 Cooperation

Cooperation relations coordinate contributions toward purposes that are shared, mutually compatible, or jointly produced to some degree. Cooperation can occur within firms, households, research groups, cooperatives, supply networks, professional communities, public institutions, commons, and informal associations. It can be supported by contracts, reciprocity, norms, trust, authority, repeated interaction, shared infrastructure, or combinations of these mechanisms.

Economic organization cannot be reduced to a choice between anonymous markets and centralized hierarchy. Powell's analysis of network forms emphasizes reciprocal communication and exchange as a distinctive organizational mode (Powell 1990), while empirical work on biotechnology shows that interorganizational collaboration can become an important locus of learning and innovation (Powell et al. 1996). Commons research likewise documents institutional arrangements through which participants can organize collective action outside a simple market-versus-state dichotomy (Ostrom 1990; Ostrom 2010).

GRE examines cooperation through contribution, coordination, learning, surplus generation, distribution, membership, and exit. Cooperation can create capacities that no participant possesses independently, including shared knowledge, standards, infrastructure, reputation, or political and bargaining capacity. It can also conceal unequal burdens or distribute benefits unevenly. The existence of joint production therefore does not settle questions of fairness, voluntariness, or governance.

Cooperation is also dynamic. Successful interaction can deepen trust and specialization, while repeated imbalance can generate resentment, dependence, or conflict. Institutional design can stabilize some cooperative patterns while displacing others. The relation-form is therefore best understood through its history and its connections to authority, trust, dependency, and higher-order collective relations.

12.6.12 Conflict

Conflict relations arise where subjects or entities contest resources, rules, obligations, recognition, control, distributions, classifications, or future trajectories. Conflict can occur within cooperation as well as between competitors. It can be explicit through bargaining, litigation, strikes, political contestation, or organizational disputes, and

it can remain latent where disagreement is constrained by authority, dependency, or the anticipated cost of expression.

Economic conflict has analytical value because it can reveal relational structures that routine coordination leaves obscure. Bargaining disputes can expose dependence on specialized labor or infrastructure; conflicts over ownership can reveal competing claims to use and control; disputes over classification can alter eligibility, remuneration, or regulatory treatment; conflicts over standards can shape market access and technological trajectories. Simmel's relational sociology treated conflict as one form of interaction rather than as evidence that social relation has disappeared (Simmel 1971). GRE adopts the narrower implication that conflict can itself reorganize economic relations.

Conflict can generate institutional change, renegotiated terms, separation, new coalitions, or further concentration of power. It can also destroy productive capacity, trust, infrastructure, or possibilities for later cooperation. The relevant analysis should therefore identify the object of contestation, the parties and their alternatives, the institutional arena, the distribution of power, the temporal dynamics of escalation or settlement, and the consequences for later relational configurations.

The relation-forms developed throughout Section 12.6 remain analytical projections of more complex configurations. Exchange can contain authority; labor can contain care; ownership can condition credit; knowledge can generate dependency; trust can support cooperation; conflict can transform institutions. GRE therefore proceeds from pairwise or named relation-forms toward relations among relations. Section 317 develops higher-order economic relations, including triadic, multilateral, collective, and institutionalized structures in which economic consequences arise from configurations that cannot be reconstructed adequately from isolated dyads alone.

12.7 Higher-Order Economic Relations

Section 12.6 introduced selected economic relation-forms as analytical vocabularies for exchange, production, labor, ownership, credit, care, knowledge, trust, authority, dependency, cooperation, and conflict. The present section examines configurations in which economically consequential structure cannot be reconstructed adequately from isolated pairwise relations alone. Its role is to extend the relational architecture from named dyads toward triadic, multilateral, collective, hyperrelational, and institutionalized arrangements, including relations among relations and collectively distributed obligations and capacities. The objective is conceptual rather than classificatory closure: to identify recurrent forms of higher-order economic organization while preserving the possibility that other forms become relevant in different historical and empirical settings. The discussion combines relational reconstruction with selected higher-order network and institutional perspectives, while treating formal hypergraph or simplicial representations as optional analytical tools rather than ontological commitments.

Pairwise representation remains useful for many economic questions. A wage relation, credit contract, ownership claim, or exchange can often be analyzed initially through relations between identifiable parties. Yet economic consequences frequently depend on a wider configuration. A platform transaction can involve a user, provider, platform operator, payment infrastructure, ranking system, and regulatory

environment. A loan can depend on a borrower–lender relation whose feasible terms are jointly conditioned by collateral ownership, guarantors, rating practices, and legal priority. A commons arrangement can distribute rights and obligations through rules applying to a group whose operation cannot be inferred from separate bilateral promises. Work on higher-order networks similarly emphasizes that interactions among groups can carry structural and dynamical information that ordinary pairwise graphs do not preserve (Battiston et al. 2020; Bick et al. 2023). GRE uses that insight selectively: higher-order representation is warranted when the configuration itself contributes explanatory content.

Definition 12.22 (Higher-order economic relation). Within GRE, a *higher-order economic relation* is a historically situated relational configuration in which the economically relevant capacities, constraints, obligations, expectations, or transformations depend materially on a combination of participants, roles, rules, or lower-order relations that cannot be represented adequately, for the inquiry at hand, as independent pairwise connections. Higher-order attribution is therefore problem-relative and should identify the explanatory loss produced by pairwise decomposition.

Definition 12.22 makes higher-order status an analytical claim rather than a synonym for numerical multiplicity. Three actors can participate in a structure that is fully reconstructed by three dyadic relations; conversely, two named organizations can stand within a relation whose content depends on internal roles, external rules, and institutional linkages that make a simple dyad inadequate. The relevant question is therefore whether decomposition preserves the mechanism under study.

Table 12.9 summarizes the principal forms developed in this section. The categories overlap. A multilateral relation can become institutionalized; a collective relation can carry collective obligations; a hyperrelation can be one representation of a relation among relations; and collective capacity can emerge from several of these structures at once.

Proposition 12.23 (Configuration-sensitive explanation). *Where an economic outcome depends materially on the joint arrangement of several relations, roles, or participants, pairwise decomposition can preserve local connections while losing configuration-sensitive mechanisms. A higher-order representation can be analytically preferable when it makes the relevant joint structure explicit and remains empirically interpretable.*

Proposition 12.23 does not establish a general superiority of higher-order models. Additional structure increases representational demands and can create new identification, measurement, and interpretation problems. The remainder of the section therefore develops higher-order forms together with their scope conditions.

12.7.1 Triadic Relations

Triadic relations arise when a third position materially changes the economic relation between two other positions. The third position can mediate, guarantee, authorize, certify, rank, finance, adjudicate, monitor, or otherwise condition interaction. Examples include buyer–seller–platform structures, borrower–lender–guarantor arrangements, worker–employer–regulator configurations, principal–agent–auditor relations, and producer–distributor–consumer chains. The analytical relevance of the third position depends on mechanism rather than headcount.

A triadic structure can generate possibilities that do not exist in the corresponding

Table 12.9: Selected forms of higher-order economic relations and their analytical roles.

Form	Analytical role	Selected questions
Triadic relation	Captures a third position that conditions a relation between two others	Mediation, brokerage, guarantee, adjudication, platform intermediation, third-party dependence
Multilateral relation	Represents coordinated or mutually conditioning relations among several participants	Joint terms, rule dependence, contribution, coalition, compatibility, shared exposure
Collective relation	Treats participation in a collectivity as economically consequential	Membership, representation, contribution, collective decision, distribution, exit
Hyperrelation	Represents one relation connecting several units or roles simultaneously	Group interaction, joint production, irreducibility, representation choice, evidential support
Relations among relations	Examines how one relation conditions, transforms, or governs another	Ownership–labor, credit–collateral, authority–knowledge, regulation–market, dependency–exit
Institutionalized relation	Stabilizes positions and interaction through rules, offices, procedures, or recognized categories	Role structure, rule scope, enforcement, succession, contestability, historical change
Collective obligation	Distributes an obligation across a group, office, institution, or coordinated structure	Attribution, contribution, discharge, residual responsibility, internal allocation
Collective capacity	Arises from coordinated relations that enable action unavailable to isolated participants	Complementarity, coordination, infrastructure, learning, resilience, access, governance

dyads considered separately. A guarantor can expand feasible credit; an auditor can alter the informational conditions of contracting; a platform can create matching capacity while also controlling visibility and access; a regulator can change bargaining or compliance conditions between firms and workers. The third position can therefore modify the terms, credibility, enforceability, or feasibility of another relation.

Triads also permit indirect dependence and brokerage. One party may become dependent on another through a third party that controls access, information, or authorization. A producer can appear to transact directly with consumers while practical access depends on a platform's ranking and payment infrastructure. Conversely, an intermediary can reduce dependence by creating alternatives, standardizing information, or supplying guarantees. The same structural location can thus support

different economic consequences under different institutional conditions.

Triadic analysis should also preserve role asymmetry. Three positions need not possess equivalent agency, responsibility, or capacity. One position may be an institutional office, algorithmic system, legal category, or infrastructure rather than a person or organization. GRE therefore specifies the relevant role of each position and asks which relation changes when the third position changes. Triadic description earns its analytical role when it identifies a mechanism that a set of disconnected dyadic descriptions would obscure.

12.7.2 Multilateral Relations

Multilateral relations involve several participants whose terms of participation are jointly conditioned. They appear in partnerships, consortia, standards bodies, supply arrangements, payment systems, insurance pools, multistakeholder governance, joint ventures, cooperatives, and many forms of collective production. A multilateral relation differs from a collection of bilateral contracts when participation by one party changes the feasible or meaningful terms available to others.

Compatibility is one source of multilateral structure. Technical standards, shared infrastructures, currencies, protocols, and platform rules can make the value or feasibility of one participant's action depend on adoption by many others. Network-effect analysis provides one familiar economic example in which system-level adoption affects the value of compatible goods and services (Katz and Shapiro 1994). The relevant higher-order mechanism can nevertheless involve more than positive network effects: congestion, exclusion, systemic exposure, coordination costs, or standard-setting power can also emerge through multilateral dependence.

Contribution structures provide another source. Joint production can require complementary inputs that have limited value in isolation. Research consortia, infrastructure projects, cooperative enterprises, and complex supply systems can depend on differentiated contributions whose timing and compatibility matter jointly. Bilateral accounting of each contribution may remain useful, yet it can fail to represent the collective production condition that links them.

Multilateral relations can also generate coalition and veto structures. Some decisions require unanimity, qualified majorities, representative procedures, delegated offices, or compatibility across several organizations. The economic effect therefore depends partly on decision rules. GRE treats those rules as part of the relational configuration when they shape contribution, access, distribution, or feasible change. Later sections on organizations, institutions, markets, and infrastructure develop these arrangements at greater depth.

12.7.3 Collective Relations

Collective relations arise when participation in a group, organization, community, association, commons, or other collectivity becomes economically consequential in its own right. The collectivity can coordinate resources, represent members, establish rules, maintain infrastructure, allocate benefits, negotiate externally, or preserve shared knowledge. Collective relation therefore concerns more than simultaneous participation by many individuals; it concerns a structure through which membership and joint organization affect capacities and obligations.

The relation between persons and groups can itself be analytically dual. Breiger's analysis of persons and groups shows how membership structures connect interpersonal and intergroup patterns (Breiger 1974). For GRE, this helps clarify why collectivity can be approached through several linked levels: subjects relate to a collective, the collective relates externally to other entities, and those external relations can feed back into the positions of members. A labor union, cooperative, professional association, household, or research consortium can therefore alter an individual's bargaining, learning, risk exposure, or access by mediating relations that no member controls independently.

Collective relations also raise questions of representation. An organization may speak or contract in the name of members without reproducing every member's preference. Internal decision procedures, delegation, voting rights, expertise, informal authority, and unequal participation shape what becomes the collective position. Treating the collective as a single actor can be useful for some questions while concealing internal relational heterogeneity for others.

Collective relation should therefore be specified with a scale and purpose. A cooperative can be treated as one entity in a market transaction and decomposed into members, offices, contribution rules, and internal conflicts when studying distribution or governance. This scale dependence follows the treatment of entityhood in Section 12.5 and prepares the later analysis of organizations, communities, commons, and institutions.

12.7.4 Hyperrelations

The term *hyperrelation* is useful when one relational object connects several participants or positions simultaneously and the joint connection is analytically meaningful. In a mathematical representation, a hyperedge can connect an arbitrary number of nodes, while simplicial or related higher-order structures can encode additional patterns of group interaction. Reviews of higher-order network methods emphasize that these representations can capture structures and dynamics unavailable to ordinary pairwise graphs (Battiston et al. 2020; Bick et al. 2023).

GRE uses hyperrelational language with ontological restraint. A group interaction need not literally be a hyperedge in the world. Hypergraph, simplicial, factor-graph, event-complex, tensor, or other representations can be selected according to the inferential task and available evidence. The analytical burden is to explain what information the higher-order object preserves and what would be lost under pairwise decomposition.

Several economic examples motivate the representation. A production task can require three complementary capabilities simultaneously; a contract can bind several parties under one joint condition; a committee decision can depend on a quorum; a platform transaction can require compatibility among user, provider, platform, and payment infrastructure; a commons rule can apply collectively to a defined participant set. In each case, the economically relevant condition may attach to the group configuration rather than to independent pairwise links.

Higher-order formalization also introduces risks. Group membership may be incompletely observed, interaction boundaries may be ambiguous, and apparent higher-order effects can sometimes be represented through latent variables or omitted mediators. Formal complexity can exceed evidential support. GRE there-

fore treats hyperrelations as an optional representation whose adequacy should be justified through the research question, mechanism, evidence architecture, and comparison with simpler alternatives.

Caution 12.24 (Higher-order representation and evidential burden). A higher-order representation should not be inferred solely from the presence of several participants. The analysis should identify the joint mechanism being represented, the evidence supporting the relevant group or relational boundary, and the inferential advantage over an adequate pairwise or latent-variable account.

12.7.5 Relations among Relations

Higher-order economic structure can arise when one relation conditions the formation, meaning, or effect of another relation. This is a relation-among-relations problem. Ownership can condition labor authority; credit can depend on collateral ownership; legal status can condition market access; trust can alter monitoring requirements; dependency can change bargaining within exchange; knowledge asymmetry can strengthen authority; care obligations can shape labor participation. The relevant analytical object is the patterned interaction among relation-forms.

Relations among relations can be reinforcing. Ownership plus financing control can deepen authority over production; accumulated trust plus repeated cooperation can reduce coordination costs; shared knowledge plus common infrastructure can expand collective learning. They can also counteract one another. Regulatory authority can constrain ownership power; collective organization can reduce asymmetric dependency; transparent information can weaken gatekeeping based on knowledge asymmetry.

Temporal order matters. A relation formed earlier can change the conditions under which a later relation becomes possible. Debt can precede and condition labor choices; previous collaboration can create trust that enables subsequent joint investment; legal recognition can transform an informal claim into an enforceable ownership relation. Conversely, a later institutional change can reinterpret earlier obligations. Higher-order analysis therefore joins relational composition to event history rather than treating the configuration as timeless.

This perspective also qualifies causal attribution. Observed outcomes may be associated with one visible relation while depending on a bundle of interacting relations. For example, a nominal price difference can reflect market concentration, financing conditions, platform access, standards, regulation, and informational asymmetry. GRE does not require that every analysis reconstruct the entire relational field. It does require that the selected explanatory relation be treated as a scoped abstraction whose omitted relational conditions remain open to investigation when they materially affect inference.

12.7.6 Institutionalized Higher-Order Relations

Higher-order relations become institutionalized when rules, roles, procedures, recognized categories, offices, or recurrent practices stabilize how several positions relate. An institution can specify who may participate, which actions are permitted, how contributions are evaluated, how disputes are resolved, and how authority or resources

move across positions. Institutionalization can therefore condense a complex relational pattern into durable expectations without eliminating its internal plurality.

Institutional analysis provides several precedents for studying such structured interaction. North emphasizes institutions as constraints shaping interaction (North 1990), while Ostrom develops rule-centered frameworks for analyzing diverse action situations and polycentric arrangements (Ostrom 2005; Ostrom 2010). GRE draws on these traditions while emphasizing the historical evolution of the relations that rules stabilize and the possibility that formal rules, enacted practices, and experienced positions diverge.

Institutionalized higher-order relations often involve roles whose meaning depends on one another. Employer and employee roles, creditor and debtor positions, regulator and regulated entity, owner and beneficiary, member and representative, or platform operator and participant acquire practical content through complementary rule structures. The institution can persist despite turnover in the persons occupying those roles. Its economic reality therefore depends partly on stabilized relations among positions rather than continuity of particular individuals.

Institutionalization can reduce uncertainty, enable coordination, and preserve collective memory. It can also make asymmetries durable, create entry barriers, stabilize obsolete practices, or detach formal authority from the conditions that originally justified it. These possibilities are empirical and normative questions rather than implications of institutional persistence itself. A later section develops institutions as relational infrastructure in greater detail; the present subsection establishes their higher-order relational basis.

12.7.7 Collective Obligations

Collective obligations arise when responsibility for contribution, maintenance, repayment, care, compliance, risk bearing, restitution, or another required performance is distributed across a collective structure. The obligation may attach to an organization as a recognized entity, to offices within it, to members under a contribution rule, or to several parties jointly. The economic significance lies in how the relational architecture allocates responsibility and in what occurs when internal allocation and external attribution diverge.

An organization's obligation to pay wages, maintain infrastructure, repay debt, satisfy safety standards, or honor a collective agreement can survive turnover among individual members or managers. Internal procedures may allocate tasks for discharging the obligation, while external law or contract recognizes the organization as the relevant obligor. Collective obligation therefore illustrates the difference between entity-level attribution and the relational processes through which performance actually occurs.

Distribution within the collective can be unequal. Some participants may possess authority to commit the group while others bear much of the practical cost. Contribution rules can allocate obligations by membership, use, benefit, capacity, role, or negotiated agreement. Commons governance research documents how rules concerning participation, monitoring, contribution, and sanction can support collective resource arrangements under some conditions (Ostrom 1990). GRE treats such arrangements as historically situated examples rather than a universal model for collective obligation.

Collective obligations can also leave residual relations after formal dissolution or exit. Debt, pension commitments, environmental remediation, data stewardship, contractual warranties, or care responsibilities may persist when an organization restructures or ceases ordinary activity. Analysis should therefore distinguish termination of the collective's coordinating structure from discharge of obligations generated during its history. This point connects higher-order relations to the residual histories discussed for entity dissolution in Section 12.5.

Remark 12.25 (Attribution and internal distribution). Collective attribution does not by itself determine how an obligation should be distributed internally. Entity-level responsibility, role-specific duties, causal contribution, benefit, capacity, legal liability, and negotiated burden sharing can point to different internal allocations. Their relevance depends on the institutional and normative framework governing the case.

12.7.8 Collective Capacities

Collective capacities are capabilities generated or made accessible through coordinated relations among several subjects, entities, roles, or infrastructures. They include capacities for production, bargaining, learning, risk pooling, standard setting, financing, research, representation, maintenance, care, emergency response, and governance. Their defining feature is configuration dependence: the capacity cannot be assigned straightforwardly to any isolated participant without reference to the relational arrangement that enables it.

Collective capacity can arise through complementarity. A research collaboration can combine distinct expertise and equipment; a supply system can coordinate specialized production stages; an insurance pool can distribute exposure; a cooperative can aggregate bargaining or purchasing power; shared infrastructure can allow participants to perform activities that would be prohibitively costly individually. Interorganizational network research provides empirical examples in which collaboration becomes a locus of learning and innovation (Powell et al. 1996). Such cases illustrate how relational organization can generate capacities beyond the pre-existing capabilities of participants.

Collective capacity is not necessarily harmonious or equally shared. A platform ecosystem can create substantial matching and coordination capacity while concentrating rule-setting power. A supply network can achieve productive specialization while producing asymmetric dependence. A financial system can pool liquidity while generating correlated exposure. Capacity at one scale can therefore coexist with vulnerability, exclusion, or reduced autonomy at another. GRE treats the distribution, accessibility, and control of collective capacity as separate analytical questions.

Capacity can also decay. Loss of trust, key participants, shared infrastructure, institutional legitimacy, financing, or tacit coordination knowledge can weaken collective performance even where formal membership persists. Conversely, repeated coordination can generate routines, standards, common knowledge, and institutional memory that make later collective action easier. Collective capacity is therefore historical rather than a static sum of individual resources.

Proposition 12.26 (Relational generation of collective capacity). *A collective capacity can be attributed to a relational configuration when its exercise depends materially on coordinated complementarities, rules, infrastructures, or shared histories that are unavailable to the relevant participants acting separately. The attribution should remain*

scale-specific and should distinguish collective capacity from its distribution, control, accessibility, and normative evaluation.

The proposition on collective capacity closes the movement from pairwise relation-forms to configuration-dependent economic possibilities. Higher-order relations can generate obligations, capacities, dependencies, and institutional positions that alter what economic subjects can do and what futures remain available to them. The forms developed here remain a provisional analytical repertoire rather than a completed taxonomy. Section 318 therefore shifts from individual higher-order forms to *relational configurations*: patterned combinations of subjects, entities, relations, boundaries, and histories that can be studied as economic architectures at different scales.

12.8 Relational Configurations

Economic analysis often requires more than identification of subjects, entities, or relation-forms. It also requires an account of how several relations are arranged together, which positions they make available, how local and wider structures constrain one another, and which patterns remain sufficiently coherent to influence later economic possibilities. This section develops *relational configuration* as an intermediate analytical object between individual relations and the larger organizations, institutions, markets, infrastructures, and fields examined later in the chapter. Its objective is to distinguish recurrent configuration forms without treating them as a complete taxonomy or as fixed ontological layers. The discussion proceeds from dyadic and neighborhood configurations through local, organizational, institutional, field, nested, and overlapping forms, and then considers configuration stability and transformation. The method is relational and historical: configuration boundaries, relevant components, and explanatory scale are selected in relation to the question under study and remain open to revision when the evidence or practical problem changes.

A configuration is therefore more than a list of connections. Two empirical settings can contain similar relation-types while differing substantially in the arrangement of those relations, the positions they create, and the possibilities available to participants. Ownership, credit, authority, trust, labor, and knowledge relations can combine so that control is dispersed in one setting and concentrated in another. Comparable exchange links can be embedded in different institutional, infrastructural, or reputational environments and thereby produce different access, bargaining, or learning conditions. Network and embeddedness traditions have long emphasized that economic action can depend on patterns of social connection and institutional context rather than on isolated transactions alone (Granovetter 1985; Wellman 1983). GRE uses this insight while keeping the unit of configuration problem-relative and historically revisable.

Definition 12.27 (Relational configuration). Within GRE, a *relational configuration* is a selected arrangement of economic subjects, entities, relations, higher-order relations, positions, rules, and relevant contextual conditions whose organization contributes explanatory content for the inquiry at hand. Configuration attribution requires an explicit analytical boundary or resolution and may be revised when another arrangement better accounts for observed capacities, constraints, dependencies, transformations, or histories.

Definition 12.27 makes configuration an analytical reconstruction rather than a

claim that the economic world is naturally partitioned into fixed relational wholes. The same participant can belong to several configurations at once; the same relation can be locally important and systemically peripheral; and a configuration that is useful for one question can obscure mechanisms relevant to another. Configuration analysis therefore asks what arrangement is being selected, which relations and conditions are included, why that resolution is useful, and what explanatory consequences follow from the selection.

Table 12.10 summarizes the principal configuration forms developed in this section. The categories overlap and can be combined. An organizational configuration can contain several local neighborhoods, participate in an institutional configuration, and occupy a position within a wider field configuration. Nested and overlapping structures therefore concern relations among analytical configurations as much as additional substantive categories.

Proposition 12.28 (Configuration-sensitive causal relevance). *Where economic capacities, constraints, or transitions depend materially on the arrangement of several relations or positions, explanation can require the configuration as an analytical object in addition to its component relations. The relevance of the configuration should be established through the mechanism, evidence, or counterfactual contrast appropriate to the inquiry rather than inferred from structural complexity alone.*

Proposition 12.28 preserves a demanding evidential standard. A complex diagram does not establish a configuration-level mechanism. Configuration analysis earns its role when arrangement affects what can happen: who can reach a resource, who can substitute for whom, which information travels, whose authorization is required, where obligations accumulate, which shocks propagate, or how later relations can form.

12.8.1 Dyadic Configurations

A dyadic configuration concerns the patterned set of economic relations connecting two analytical positions. Section 12.6 distinguished relation-forms such as exchange, labor, ownership, credit, trust, authority, dependency, cooperation, and conflict. In practice, two positions can participate in several of these forms simultaneously. The dyadic configuration records that composition and examines how the relations condition one another.

An employment relation illustrates the point. Worker and employer can be connected through wage exchange, productive cooperation, authority, knowledge dependence, trust, legal obligation, and possible conflict. A creditor and borrower can be connected through credit, collateral-linked ownership claims, information disclosure, monitoring authority, and dependency. A care relation can include material transfer, obligation, trust, labor, and asymmetric exit costs. Treating each relation separately remains useful for some questions, yet the joint configuration can explain why a change in one relation modifies another.

Dyadic configuration analysis can therefore distinguish relation bundles from isolated relation labels. It asks which relations are active, which are latent, which have institutional priority, and which change the feasible alternatives of the two positions. The same nominal contract can generate different economic consequences when accompanied by different knowledge, dependency, trust, or authority relations.

This perspective also prevents overreading dyads as self-contained. Two-party con-

Table 12.10: Selected relational configuration forms and their analytical roles.

Configuration form	Analytical focus	Illustrative questions
Dyadic	Arrangement of several relation-forms between two positions	Which relations coexist, reinforce, offset, or transform one another?
Relational neighborhood	Relations surrounding a focal subject, entity, or position	Which nearby ties provide access, information, obligation, exposure, or alternatives?
Local	Bounded pattern of positions and relations relevant to a local process	Which local mechanisms generate coordination, exclusion, dependence, or learning?
Organizational	Internal and boundary-crossing arrangement of roles, authority, resources, knowledge, and obligations	How does organizational architecture distribute capacity, control, responsibility, and dependence?
Institutional	Pattern stabilized through rules, categories, offices, procedures, expectations, and enforcement	Which relations are reproduced, authorized, constrained, or made legible?
Field	Wider distribution of positions, resources, relations, and interaction possibilities around a domain of activity	Which positions, dependencies, and pathways shape participation without requiring direct connection among all actors?
Nested	Configurations embedded within or conditioned by configurations at other scales	Which cross-scale relations preserve, amplify, or transform local structure?
Overlapping	Configurations sharing subjects, entities, relations, resources, or rules	Where do multiple memberships, obligations, authorities, or classifications interact?

figurations are usually situated within wider legal, organizational, infrastructural, and social conditions. A worker–employer configuration depends on labor law, occupational norms, labor-market alternatives, household conditions, and technological organization; a borrower–lender configuration can depend on payment infrastructures, bankruptcy rules, collateral registries, and monetary institutions. Dyadic analysis therefore offers a local analytical resolution whose boundary should remain explicit.

12.8.2 Relational Neighborhoods

A relational neighborhood is the selected set of economically relevant relations surrounding a focal subject, entity, or position. The concept shifts attention from one

tie to the immediate relational environment through which a participant obtains information, resources, authorization, support, obligations, exposure, and alternatives. Its boundary can be defined by direct relation, short relational distance, shared institution, functional dependence, or another criterion suited to the inquiry.

Relational neighborhoods matter because local opportunity and constraint can depend on the composition of nearby relations. Two firms with similar internal capabilities can face different possibilities when one has diverse suppliers, financiers, knowledge partners, and distribution channels while another depends on a narrow set of counterparties. Two households with similar income can differ in practical resilience because kinship support, care obligations, credit access, transport, housing, or public-service relations differ. Neighborhood composition can therefore mediate the conversion of nominal resources into effective capacities.

Neighborhood analysis also makes alternatives visible. Dependency often depends less on the presence of one important relation than on the absence of credible substitutes. A focal actor embedded in several partially substitutable relations can possess greater room for revision or exit than one whose neighborhood is highly concentrated. Conversely, dense local relations can generate coordination and trust while also increasing exposure to correlated disruption, reputational closure, or locally enforced norms.

The relevant neighborhood is problem-specific. Geographic proximity can matter for some labor, care, infrastructure, or retail questions, while informational, contractual, technological, or institutional proximity can matter more elsewhere. GRE therefore treats neighborhood as a relational resolution rather than a fixed spatial radius.

12.8.3 Local Configurations

Local configurations extend neighborhood analysis to a bounded pattern containing several positions and relations that jointly sustain a process. A local configuration can be spatial, organizational, technological, institutional, or functional. Examples include a workplace team, a production cluster, a local credit ecology, a care network, a procurement arrangement, a research collaboration, or a neighborhood service system. The term *local* therefore refers to analytical scale rather than necessarily to physical distance.

The economic importance of a local configuration can arise from repeated interaction, complementarity, coordination costs, common infrastructure, shared rules, tacit knowledge, or locally available alternatives. Such configurations can generate capacities that are difficult to attribute to one participant. They can also generate exclusion where access depends on membership, reputation, credentialing, interoperability, or proximity to a local hub.

Local configurations are particularly useful for studying heterogeneity within larger systems. An industry described at national scale can contain local configurations with different labor practices, financing arrangements, technological standards, or trust structures. A large organization can contain teams or divisions with distinct knowledge flows and authority patterns. Aggregate indicators can therefore conceal local arrangements that matter for intervention or explanation.

Locality remains relative to the selected process. A configuration that is local from the perspective of a global supply system can be expansive from the perspective of a worker or household. GRE consequently records the focal process, boundary, and

comparison scale rather than treating *local* as an intrinsic property.

12.8.4 Organizational Configurations

Organizational configurations concern patterned relations among roles, units, resources, rules, information channels, authority positions, and external interfaces within an organized economic entity or coordinated collective. The concept provides a configuration-level view of organizations while leaving detailed analysis of organizational boundaries, membership, and stabilization to later sections of the chapter.

An organizational chart can record formal reporting lines while leaving many economically consequential relations implicit. Expertise can be concentrated outside formal authority; budget control can sit apart from operational responsibility; informal trust networks can accelerate or obstruct coordination; external contractors can perform central functions without formal membership; digital systems can mediate access and visibility across units. Organizational configuration therefore includes both formal and practically operative relations where the inquiry requires them.

Several organizational properties can be configuration-sensitive. Redundancy can depend on whether comparable capacities exist in more than one unit. Bottlenecks can arise where many processes depend on one role, database, authorization channel, or infrastructure. Learning can depend on cross-unit ties rather than on aggregate expertise. Responsibility can become diffuse when authority, information, and implementation are distributed across different positions. These patterns can remain invisible if an organization is treated as a unitary actor.

GRE does not infer organizational quality from any one configuration. Centralization can accelerate some decisions and intensify some dependencies; decentralization can preserve local knowledge and also fragment coordination. Dense internal relations can support learning and create conformity. The analytical task is to reconstruct how a given arrangement generates capacities, constraints, exposures, and possible transformations under specified conditions.

12.8.5 Institutional Configurations

Institutional configurations arise where rules, categories, offices, procedures, expectations, and enforcement arrangements stabilize patterned economic relations across repeated situations. Institutional analysis therefore adds more than the existence of a rule. It asks how several rules and roles combine, which positions they create, what behavior becomes recognized or excluded, and how institutional components condition one another.

Institutional configurations can include legal classifications, licensing arrangements, accounting standards, eligibility rules, professional norms, enforcement procedures, dispute-resolution mechanisms, and recognized offices. Their economic significance often emerges through composition. A property right depends on rules of recognition, transfer, exclusion, registration, enforcement, and remedy; a credit system depends on contractual, monetary, accounting, informational, and insolvency arrangements; labor-market participation can depend on employment classification, immigration status, credential recognition, tax treatment, and social-insurance rules.

Institutional configurations also shape legibility. Categories determine which subjects, entities, assets, transactions, and obligations become administratively visible. That legibility can enable coordination, protection, taxation, comparison, or enforcement while also compressing heterogeneous relations into standardized forms. Later analysis of symbolized economic relations will examine representation in greater depth; the present concern is the configuration through which multiple institutional representations and rules jointly structure participation.

Institutional configurations are historical and contestable. Rules can persist while their interpretation changes; offices can retain names while their practical authority shifts; informal practices can alter how formal procedures operate. Institutional stability therefore requires attention to implementation, recognition, and relational reproduction in addition to written rules.

12.8.6 Field Configurations

Field configurations describe wider distributions of positions, relations, resources, capacities, rules, expectations, and pathways around a domain of economic activity. A field representation can be useful where actors affect one another through shared institutions, competition, standards, reputation, prices, infrastructures, or positional relations even when direct ties are incomplete. Sociological field approaches similarly emphasize structured positions and interaction arenas rather than reducing collective outcomes to isolated actors (Bourdieu and Wacquant 1992; Fligstein and McAdam 2012).

Within GRE, field language remains an analytical option under ontological restraint. A field configuration can represent gradients of access, concentration of knowledge, distribution of bargaining alternatives, technological compatibility, reputational standing, regulatory exposure, or other positional conditions. The representation should specify which variable or relation gives the field interpretation empirical meaning. Invoking a field metaphor without such specification adds little explanatory value.

Field configurations can capture indirect conditioning. A firm can face altered financing conditions because of a sector-wide shift in risk perception without direct interaction with every relevant investor. A worker's bargaining position can change because of regional labor demand, credential structures, or platform rules. A household's housing possibilities can change through interest rates, land-use regulation, and neighborhood demand. These effects can be relational even when they are mediated through aggregate or institutional mechanisms.

Field boundaries remain contestable. Economic domains overlap, and the actors that shape a field need not coincide with those formally classified inside it. Regulators, infrastructures, financial institutions, standards bodies, communities, and technological providers can influence a production or market field from positions that appear external under a narrower classification. Field analysis therefore requires explicit boundary reasoning and sensitivity to cross-field coupling.

12.8.7 Nested Configurations

Nested configurations arise when one relational configuration is embedded within, governed by, dependent on, or otherwise conditioned by another configuration at

a different analytical scale. Households can be situated within neighborhoods and welfare institutions; teams within firms; firms within supply systems and regulatory regimes; local credit relations within national monetary and legal architectures. Nesting can therefore connect micro-, meso-, and macro-level descriptions without assuming that these levels form a single rigid hierarchy.

Nesting matters when processes at one scale change the feasible relations at another. A national legal rule can alter household or organizational contracts; organizational restructuring can change local labor and care relations; local innovations can diffuse into sectoral standards; a transnational infrastructure can constrain domestic institutional options. Cross-scale influence can move in several directions and can be asymmetric.

Analytical nesting should distinguish containment from dependence. A configuration can be geographically inside another while remaining weakly dependent on it, and a configuration can be strongly conditioned by a distant system without spatial containment. Technical platforms, payment systems, cloud infrastructures, standards, and global supply arrangements illustrate forms of functional nesting that cannot be represented adequately by geography alone.

Nested analysis also raises aggregation problems. Properties of a higher-level configuration cannot always be inferred by summing lower-level properties, while higher-level regularities do not determine each local history. GRE therefore treats cross-scale explanation as a problem of coupling, mediation, and transformation. Later sections on multiscale architecture develop this issue more systematically.

12.8.8 Overlapping Configurations

Overlapping configurations share subjects, entities, relations, resources, infrastructures, rules, or representations without being reducible to one another. A person can participate simultaneously in household, workplace, professional, credit, care, community, and platform configurations. An organization can belong to several supply systems, regulatory domains, financial networks, standards communities, and knowledge collaborations. Overlap is therefore a common condition of economic life rather than an exceptional complication.

Overlap can generate complementarity. Knowledge acquired in one configuration can support participation in another; infrastructure can serve several communities; reputational standing can transfer across domains; shared membership can facilitate coordination. It can also create conflict where obligations, classifications, schedules, or authorities compete. Household care demands can conflict with employment arrangements; professional obligations can conflict with organizational incentives; platform rules can conflict with public regulation; multiple creditors can assert incompatible priorities.

Overlapping configurations are especially important for responsibility and intervention. An action targeted at one configuration can propagate through shared participants or resources into others. Closing a workplace affects households and local services; changing a platform's ranking rules can alter producer, advertising, labor, and consumer configurations; infrastructure investment can reconfigure property, transport, employment, and ecological relations simultaneously. The relevant impact boundary can therefore exceed the administrative boundary of the intervention.

Overlap also complicates identity and membership. A subject can hold different

roles and rights in different configurations, and a relation can be interpreted differently across institutional settings. GRE therefore avoids assigning one total relational position to a participant where several configuration-specific positions are analytically relevant.

12.8.9 Configuration Stability

Configuration stability concerns the persistence of an economically relevant pattern despite events, turnover, local variation, or environmental change. Stability does not require immobility. A configuration can remain recognizable while participants change, relations are renegotiated, resources are replaced, or routines adapt. The relevant question is which structural or functional features persist at the resolution required by the inquiry.

Several dimensions of stability can diverge. Membership can be stable while authority relations change; formal rules can be stable while informal practices shift; network connectivity can remain similar while resource flows change; productive output can persist while the distribution of risk or responsibility changes. A statement that a configuration is stable should therefore specify the dimension and time horizon involved.

Stability can arise through repeated interaction, institutional enforcement, sunk investment, complementarity, reputation, shared infrastructure, dependency, learning, or active maintenance. Some configurations persist because they continue to generate valued capacities; others persist because alternatives are costly or because power and access are unevenly distributed. Persistence therefore carries no automatic normative endorsement.

Remark 12.29 (Dimension-relative configuration stability). Configuration stability should be reported relative to selected dimensions, scales, and time horizons. Persistence of one pattern can coexist with transformation of another, and a configuration that appears stable at aggregate scale can contain substantial local reorganization.

Stability can also be produced through compensatory change. Organizations replace staff, institutions reinterpret rules, supply systems reroute flows, and households redistribute responsibilities to preserve some higher-level function. Such adaptation can maintain continuity while shifting burdens across participants. GRE therefore distinguishes stability of the configuration from stability of the conditions experienced by each subject within it.

12.8.10 Configuration Transformation

Configuration transformation occurs when the arrangement of positions, relations, rules, boundaries, or relevant contextual conditions changes sufficiently to alter the mechanisms or possibilities being studied. Transformation can be incremental, cumulative, abrupt, deliberately induced, or generated through interactions that were not centrally designed. It can involve relation formation or dissolution, role redefinition, entry and exit, institutional change, technological substitution, resource reallocation, new representations, or changes in cross-scale coupling.

The history of transformation matters because similar endpoint diagrams can conceal different trajectories. A concentrated market position reached through merger

can differ in obligations and expectations from one produced by technological standardization or network effects. A cooperative arrangement created through negotiated institution-building can differ from one produced by emergency coordination even if the later membership pattern appears similar. Event order can shape trust, legitimacy, dependency, learning, and available alternatives.

Transformation can also alter the analytical boundary itself. New infrastructures can connect previously separate configurations; institutional reforms can create new categories of membership; technological change can move functions across organizational boundaries; crisis can expose relations that ordinary accounting treated as external. Configuration analysis therefore permits the unit of analysis to change when the economic mechanism changes.

Some transformations preserve many local relations while changing their joint consequences. A new rule can alter bargaining across an existing network; a change in information architecture can modify authority without changing formal ownership; new interoperability can reduce dependency by making alternatives feasible. Configuration-level analysis is useful precisely because transformation can occur in arrangement and conditioning as well as in the presence or absence of individual ties.

Remark 12.30 (Revisable configuration attribution). A relational configuration should remain a revisable analytical commitment. When later evidence shows that the selected boundary, scale, or relation set obscures an important mechanism, GRE permits reconstruction at another resolution rather than preserving the original configuration for classificatory consistency alone.

The configuration perspective developed in this section prepares more precise analysis of economic boundaries and membership. Once a configuration has been selected, questions arise concerning who or what is included, which relations cross its boundary, how entry and exit occur, and how inclusion or exclusion changes capacities and obligations. The following analysis of boundaries and membership develops those questions directly.

12.9 Boundaries and Membership

Economic configurations become analytically usable only when some distinction is drawn between what is treated as belonging to the configuration and what is treated as outside it, adjacent to it, or connected across its boundary. Such distinctions can be legal, organizational, institutional, functional, spatial, technical, statistical, social, or analytical, and they need not coincide. This section develops boundaries and membership as historically produced and problem-relative dimensions of economic architecture. Its objective is to clarify how economic boundaries are formed and maintained, how membership is attributed and experienced, how entry and exit alter relations and capacities, and how boundaries become contested or transformed. The discussion proceeds across economic, organizational, institutional, market, and community boundaries before examining entry and exit, inclusion and exclusion, multiple membership, contestation, and transformation. The method is relational and historical: boundaries are treated as consequential structures whose analytical relevance depends on the mechanisms and histories under study rather than as naturally given partitions of economic reality.

A boundary can stabilize coordination by identifying who may participate, which

rules apply, which assets or obligations are attributed to a configuration, and where responsibility is located. The same boundary can also conceal cross-boundary dependence, redistribute exposure, or make some relations weakly visible. Organizational law, for example, can create legally consequential partitions among assets and creditor claims (Hansmann and Kraakman 2000), while economic activity within those legal partitions can remain deeply connected to suppliers, households, infrastructures, communities, regulators, and financial systems. Institutional analysis similarly emphasizes that rules structure interaction and shape the feasible conduct of participants (North 1990). GRE therefore treats boundary drawing as both an object of economic inquiry and a methodological responsibility.

Membership requires a similarly differentiated treatment. Formal membership can coexist with weak participation; non-members can exercise substantial influence; a subject can receive benefits without decision rights, bear obligations without recognition, or be exposed to consequences without having entered the configuration voluntarily. Economic inclusion is therefore not exhausted by a binary indicator of membership. The analysis should distinguish, where relevant, among formal status, participation, access, entitlement, obligation, representation, control, exposure, and practical ability to exit.

Definition 12.31 (Economic boundary). Within GRE, an *economic boundary* is a historically situated distinction that organizes the attribution of subjects, entities, relations, resources, rules, capacities, obligations, or consequences to an economic configuration for a specified institutional, practical, or analytical purpose. Boundary attribution remains revisable when cross-boundary mechanisms or changing conditions make another delineation more explanatory.

Definition 12.32 (Economic membership). Within GRE, *economic membership* denotes a specified relation of belonging, participation, recognition, entitlement, obligation, representation, or attachment to an economic configuration. Different dimensions of membership may diverge and should be distinguished when that divergence affects capacities, responsibilities, access, exposure, or feasible exit.

Definitions 12.31 and 12.32 separate boundary from membership. A boundary concerns the delineation of a configuration or domain; membership concerns how a subject or entity stands in relation to that delineation. The two interact, yet neither determines the other completely. Some boundary-crossing participants can remain economically central, while formally recognized members can occupy marginal or weakly empowered positions.

Table 12.11 summarizes several boundary and membership dimensions used in this section. The dimensions are illustrative rather than exhaustive, and their relevance varies with the inquiry.

Proposition 12.33 (Boundary–membership non-equivalence). *Where legal, organizational, institutional, functional, or relational boundaries diverge, formal membership alone may provide an incomplete account of economic participation, influence, obligation, or exposure. Analysis should identify the boundary dimension relevant to the mechanism under study and distinguish it from other membership dimensions when their divergence is consequential.*

Proposition 12.33 is methodological as well as substantive. A study can obtain a clean sample by using one administrative category while still misrepresenting the mechanism if the economically relevant relations cross that administrative boundary. Conversely, expanding the analytical boundary indefinitely can destroy explanatory

Table 12.11: Selected dimensions of economic boundaries and membership.

Dimension	Boundary or membership function	Illustrative analytical questions
Legal	Allocates recognized rights, duties, personality, title, liability, or jurisdiction	Which legal distinctions organize claims, responsibility, or asset separation?
Organizational	Differentiates internal roles and processes from external relations	Which activities, resources, and authorities are treated as internal to an organization?
Institutional	Specifies the scope of rules, categories, procedures, and enforcement	To whom do rules apply, and who can invoke, interpret, or contest them?
Market	Delimits participants, products, substitutes, venues, or interaction domains	Which exchanges and alternatives are treated as belonging to the same market process?
Community	Organizes belonging, reciprocity, stewardship, identity, or shared obligation	Which forms of participation and responsibility define practical membership?
Functional	Selects components required for a mechanism or capacity	Which formally external actors or resources are functionally necessary to the configuration?
Access and entitlement	Determines eligibility to use resources, services, infrastructures, or institutions	Which forms of membership create access, and which forms of access exist without membership?
Exposure and obligation	Extends consequences, duties, or risks across or beyond formal membership	Who bears effects or obligations despite weak recognition or decision authority?
Exit and permeability	Conditions movement across boundaries and continuation of relations after crossing	What costs, residual obligations, dependencies, or capacities shape practical exit?

resolution. Boundary selection therefore requires both inclusion discipline and exclusion discipline: the analysis should include cross-boundary relations that materially condition the process while retaining a tractable and interpretable unit of inquiry.

12.9.1 Economic Boundaries

Economic boundaries are distinctions through which activities, relations, resources, and consequences are attributed to an economic domain or configuration. They can be produced through law, accounting, organizational practice, technical architecture, statistics, geography, custom, contractual classification, or scholarly analysis. Several boundaries can coexist around the same activity, and their divergence can be economically meaningful.

A firm’s accounting boundary, for example, can differ from the functional boundary of production. Purchased inputs, outsourced labor, logistics, cloud services, licens-

ing, household care, public infrastructure, and regulatory support can remain outside the firm's formal accounts while contributing to its productive capacity. A household boundary can identify residents or kin while leaving translocal remittances, care obligations, shared assets, and informal transfers partly outside the observed unit. A national accounting boundary can classify cross-border transactions in one way while supply, ownership, knowledge, or ecological relations extend across several jurisdictions.

Economic boundaries therefore perform at least two analytical functions. First, they support attribution: output, cost, obligation, control, risk, or responsibility can be associated with a selected unit. Second, they shape visibility: relations inside the boundary are often easier to record, govern, or compare than relations that cross it. Boundary-based visibility can be useful without being complete. GRE asks which boundary generated the representation and which economically consequential relations remain outside it.

Boundaries can also influence the activity they describe. Classification into a regulated market, an employment category, a taxable entity, a household, or an eligible beneficiary group can change rights, incentives, reporting requirements, and access. Boundary making can therefore function as a performative institutional act rather than a passive description. This possibility reinforces the distinction between analytical boundary selection and claims about naturally existing economic partitions.

12.9.2 Organizational Boundaries

Organizational boundaries distinguish activities and positions treated as internal to an organization from those coordinated through external exchange, contract, partnership, regulation, or other relations. Coase's analysis of the firm made the relation between internal direction and market coordination a central economic question (Coase 1937). Subsequent institutional and organizational analysis has shown that the relevant boundary can also concern asset ownership, decision rights, contractual governance, legal personality, knowledge, and responsibility.

The organizational boundary is rarely one-dimensional. Employees can work inside an organization without owning it; contractors can participate deeply in internal processes while remaining legally external; subsidiaries can be legally separate while operationally integrated; shared-service organizations can centralize functions across formally distinct entities. Digital platforms further complicate the distinction when independent participants operate under privately specified technical rules, ranking systems, payment infrastructures, and access conditions.

Organizational law can stabilize some boundaries through legal entity formation and asset partitioning (Hansmann and Kraakman 2000). These legal boundaries matter for creditor claims, liability, control, and continuity, yet practical coordination can cross them extensively. GRE therefore distinguishes the legal boundary of the entity from the functional, informational, authority, and resource boundaries of organizational activity.

Boundary analysis also bears on responsibility. A function can be outsourced without transferring every causal dependency or social consequence associated with it. Conversely, holding an organization responsible for every external relation connected to it can erase distinctions of control and practical capacity. The relevant attribution therefore depends on the mechanism, degree of control, institutional

rules, and the specific responsibility being examined.

12.9.3 Institutional Boundaries

Institutional boundaries concern the scope within which rules, categories, norms, procedures, offices, and enforcement arrangements are recognized as applicable. North's formulation of institutions as constraints structuring interaction highlights how rules can organize incentives and expectations across economic activity (North 1990). From a GRE perspective, institutional scope is also relational: the same rule can have different effects depending on who can invoke it, who is classified under it, which authorities interpret it, and which relations remain weakly covered.

Institutional boundaries can be jurisdictional, categorical, procedural, or functional. Labor protections can depend on employment classification; welfare eligibility can depend on household or income categories; financial regulation can depend on whether an activity falls within a statutory definition; professional rules can apply only to recognized members; platform governance can apply to users who accept terms without possessing meaningful authority over rule formation.

The boundary of an institution can therefore differ from the boundary of its consequences. A legal rule enacted in one jurisdiction can affect firms and households elsewhere through trade, finance, standards, or supply relations. A classification can exclude a group formally while shaping its opportunities indirectly. Institutional analysis should consequently identify both the formal domain of application and the wider relational field through which effects propagate.

Institutional boundaries can also be layered. Local, municipal, national, transnational, professional, organizational, and technical rules can apply simultaneously. Their overlap can generate complementary protections, jurisdictional gaps, conflicting obligations, or opportunities for strategic boundary use. The economic relevance of an institutional boundary often lies in these interactions as much as in the text of any single rule.

12.9.4 Market Boundaries

Market boundaries specify which participants, products, services, locations, technologies, or transactions are treated as belonging to a common domain of exchange and competition. Such boundaries are important for price comparison, competition analysis, strategy, regulation, and empirical measurement, yet they are often constructed through judgments about substitutability, participation, access, and institutional context.

A product can be a close substitute for another in one use and a poor substitute in another. Geographic distance can matter greatly for perishable goods and little for some digital services. Technical standards can divide or connect markets; transport infrastructure can enlarge effective geographic reach; regulation can create jurisdictional segmentation; platforms can create privately governed exchange environments that overlap with wider markets. Market boundaries therefore change as technologies, institutions, preferences, infrastructures, and access conditions change.

Economic sociology and substantivist traditions also caution against treating market exchange as socially detached. Economic action can remain embedded in ongoing

social relations (Granovetter 1985), and Polanyi's instituted-process perspective situates exchange alongside other forms of economic integration (Polanyi 1957). These insights suggest that a market boundary can be analytically useful while remaining porous to relations of trust, authority, reciprocity, regulation, care, and community.

GRE consequently treats market delineation as a problem-relative analytical operation. The relevant question is not simply whether a market has a boundary, but which mechanisms make a particular boundary useful for the inquiry and which cross-boundary relations materially affect the observed process.

12.9.5 Community Boundaries

Community boundaries organize forms of belonging, reciprocity, stewardship, identity, obligation, shared resource use, or mutual support. Their economic significance can arise through access to common resources, informal insurance, care, knowledge, reputation, collective bargaining, mutual aid, or rules governing contribution and use. Commons research provides well-known examples in which locally organized rules and participation structures become important to collective resource governance (Ostrom 1990).

Community boundaries need not coincide with residence, kinship, citizenship, legal organization, or cultural identity. A professional community can be translocal; a neighborhood can contain several overlapping communities; an online community can organize economically consequential knowledge or support without geographic proximity; a resource community can be defined by use rights rather than identity. Membership criteria can also change through migration, technological change, institutional recognition, conflict, or generational turnover.

Community boundaries can support trust and reciprocal expectation, yet they can also generate exclusion, hierarchy, or unequal burdens. A strong internal relation can increase collective capacity while raising entry barriers for outsiders. Conversely, highly permeable boundaries can broaden access while weakening some mechanisms of reciprocity or stewardship. GRE treats these possibilities empirically and historically rather than assuming that either closure or openness is generally preferable.

The analytical challenge is therefore to identify which form of belonging is economically relevant. Formal membership, participation in shared practices, contribution, recognition by others, access to resources, and exposure to community sanctions can diverge. Community membership is consequently another case in which a binary classification can conceal important relational differences.

12.9.6 Membership Entry and Exit

Entry and exit are processes through which membership relations are formed, altered, or terminated. Their economic significance depends on the conditions under which crossing a boundary is possible, the capacities required to do so, the obligations that accompany entry, and the residual relations that remain after exit. Entry and exit therefore provide information about boundary permeability and about the distribution of practical alternatives.

Entry can require payment, qualification, sponsorship, recognition, identity verification, ownership, contribution, location, technical compatibility, legal status, or

acceptance by incumbent members. These requirements can serve legitimate functions such as safety, coordination, quality assurance, or resource stewardship, while also distributing access unevenly. The same formal entry rule can impose different practical burdens on subjects with different resources, histories, information, or institutional standing.

Exit similarly ranges from low-cost disengagement to highly constrained separation. A consumer can often switch suppliers more readily than a worker can leave a specialized labor relation, a household can relocate, or a community can abandon shared infrastructure. Contractual obligations, sunk investment, data portability, reputation, social ties, debt, legal status, geographic immobility, care responsibilities, and network dependence can all shape the practical cost of exit.

Exit also need not terminate every relation. Financial liabilities, confidentiality duties, pension rights, data traces, reputational effects, care obligations, environmental responsibilities, or claims to shared assets can persist. The event of formal exit should therefore be distinguished from the longer process through which relations are unwound, transformed, or retained.

Remark 12.34 (Practical permeability). Boundary permeability is better treated as a situated capacity than as a formal permission alone. A boundary can be legally open while remaining practically difficult to cross because the resources, information, alternatives, or institutional recognition required for entry or exit are unevenly distributed.

12.9.7 Economic Inclusion and Exclusion

Inclusion and exclusion concern the distribution of membership, access, participation, representation, entitlement, and exposure across a configuration. These dimensions can diverge. A subject can be included as a worker while excluded from governance; included as a customer while excluded from ownership; included in an administrative category while lacking effective access to the associated benefit; or excluded from formal membership while bearing substantial consequences of the configuration.

Economic inclusion should therefore be specified by object. Inclusion in a market differs from inclusion in organizational decision making; access to credit differs from participation in rule formation; legal recognition differs from practical ability to use an institution. The same distinction applies to exclusion. Exclusion from a resource, a role, a right, an information channel, or a decision process can have different mechanisms and consequences.

Some exclusion is constitutive of bounded organization. A cooperative, profession, insurance pool, public programme, or resource-governance arrangement can require eligibility criteria or defined participation rules. The analytical question is how those criteria are formed, what functions they serve, who bears their costs, and how they interact with alternative forms of access. Evaluation requires situated normative commitments and cannot be derived from the existence of a boundary alone.

Exclusion can also be indirect. Technical design, documentation requirements, scheduling, language, pricing, geography, reputation systems, or data requirements can restrict participation without an explicit exclusion rule. Relational analysis is useful here because it asks how the practical path to participation is structured, rather than inferring inclusion from nominal availability.

12.9.8 Multiple Membership

Economic subjects commonly belong to several configurations at once. A person can simultaneously be a household member, employee, borrower, shareholder, citizen, professional, platform user, community participant, caregiver, and member of several organizations. An organization can belong to supply networks, industry associations, payment systems, regulatory regimes, standards organizations, ownership groups, and research collaborations. Multiple membership is therefore a normal feature of relational economic architecture.

Multiple memberships can generate complementarity. Membership in one configuration can provide credentials, knowledge, trust, resources, or access that supports participation in another. It can also generate conflict where roles, obligations, loyalties, time demands, reporting rules, or authorities diverge. A professional duty can conflict with an organizational incentive; household care obligations can constrain employment schedules; participation in one technical ecosystem can limit compatibility with another.

Memberships can also differ in strength and form. Some are voluntary and revisable; others arise through birth, residence, legal status, dependency, contractual commitment, or infrastructural necessity. Some confer voice; others mainly impose obligations. Some can be exited individually; others remain linked to a household, organization, territory, or installed technical system. GRE therefore resists treating a subject's memberships as interchangeable affiliations.

Multiple membership complicates causal attribution and responsibility. An observed action can reflect pressures and capacities generated across several configurations, and an intervention targeted at one membership can propagate through others. Analysis should identify which membership relation is active in the mechanism under study and where overlap changes the feasible response.

12.9.9 Boundary Contestation

Boundaries become contested when participants disagree about who or what belongs within a configuration, which rules apply, where responsibility ends, or which relations should be recognized as economically relevant. Such contestation can concern legal classification, organizational jurisdiction, market definition, community membership, employment status, ownership scope, professional authority, or the attribution of external costs and benefits.

Boundary contestation is economically consequential because classification can change rights, obligations, prices, liability, representation, access, and bargaining position. Disputes over whether a worker is an employee or contractor, whether a platform is a neutral intermediary or organizing authority, whether a resource is private or common, or whether an activity belongs within a regulated domain can reconfigure the relations attached to the classification.

The authority to draw a boundary is itself part of the relational structure. Legislatures, courts, regulators, organizations, professions, platforms, statistical agencies, researchers, and communities can possess different capacities to define categories and have those definitions recognized. Boundary-setting power can therefore become an object of economic analysis, especially when one actor's classification changes the feasible actions of others.

Contestation also provides epistemic information. Disputes can reveal that an inherited boundary no longer matches practical organization, that costs are being externalized, that new technologies connect previously separate domains, or that several legitimate boundary descriptions serve different purposes. GRE treats contestation as evidence that boundary attribution may require reconstruction, while preserving the possibility that some boundaries remain institutionally necessary or analytically useful.

12.9.10 Boundary Transformation

Boundary transformation occurs when the distinctions organizing membership, attribution, access, responsibility, or participation change. Transformation can follow institutional reform, organizational restructuring, technological innovation, merger, outsourcing, migration, crisis, infrastructure development, changes in standards, or gradual shifts in social recognition. It can enlarge, contract, layer, fragment, or reconnect previously separate configurations.

Boundary change can alter economic capacities even when many underlying subjects and resources remain present. A new interoperability standard can connect previously separated user groups; legal recognition can bring informal relations within a regulated domain; outsourcing can move activities across an organizational boundary while retaining technical dependence; a merger can combine assets and authority previously held by separate entities; decentralization can distribute decision rights across several organizational units.

Transformation can also generate boundary lag. Formal classifications sometimes persist after practical relations have changed, while practical expectations can persist after legal categories have been revised. Statistical and accounting systems can continue to represent an earlier architecture. These lags matter because policy, contracts, organizational decisions, and empirical research may respond to the recorded boundary rather than to the changing relational configuration.

Remark 12.35 (Revisable boundary attribution). Boundary attribution should remain open to revision when institutional change, technological development, new evidence, or altered relational structure changes the mechanism under study. Revision should preserve provenance: the earlier boundary, the reason for changing it, and the consequences of the new delineation should remain traceable where they materially affect interpretation.

Boundaries and membership provide a vocabulary for determining which relations are treated as internal to a configuration and which cross its selected edge. That distinction prepares the analysis of internal and external economic relations, where coordination, authority, resource and knowledge flows, exchange, regulation, and mediation can be examined without assuming that formal boundaries determine the actual pathways through which economic effects travel.

12.10 Internal and External Relations

Economic analysis frequently distinguishes relations that operate within a selected configuration from relations that connect that configuration to actors, institutions, resources, and processes represented outside it. This distinction is useful for studying

coordination, authority, resource and knowledge movement, exchange, regulation, mediation, and exposure, yet its meaning depends on the boundary and scale chosen for inquiry. This section develops internal and external relations as boundary-relative components of economic architecture. Its objective is to clarify how internal coordination and authority coexist with cross-boundary exchange, cooperation, regulation, and mediation, and how these relations become coupled over time. The discussion proceeds from internal coordination, authority, resource flow, knowledge flow, trust, and conflict to external exchange, cooperation and competition, regulation, mediation, and internal–external coupling. The method is relational and historical: internality and externality are treated as analytically specified positions within a selected configuration rather than as intrinsic properties of a relation.

The distinction is especially important because formal boundaries and effective economic pathways can diverge. Coase’s analysis of the firm provides a classical formulation of the contrast between coordination through the price mechanism and coordination within the firm (Coase 1937). Later institutional and organizational research has developed richer accounts of governance structures, rules, networks, and hybrid arrangements (Williamson 2000; Powell 1990). GRE uses these traditions as reference points while retaining a problem-relative account of the boundary itself. A relation classified as internal to a corporation can remain external to a division, local unit, profession, or accounting centre; a relation external to a firm can be internal to an industry network, regulatory regime, platform ecosystem, or community. The analytical task therefore includes specifying the configuration relative to which the distinction is made.

Definition 12.36 (Internal economic relation). For a selected economic configuration C and analytical purpose q , an *internal economic relation* is a relation represented as operating among subjects, entities, roles, resources, or processes attributed to the interior of C in a way that contributes to the mechanism examined under q . Its internal status is relative to the selected boundary, scale, and purpose.

Definition 12.37 (External economic relation). For a selected economic configuration C and analytical purpose q , an *external economic relation* is a relation that crosses the selected boundary of C or connects components represented within C to subjects, entities, rules, resources, or processes represented outside it, where that connection is relevant to the mechanism examined under q .

Definitions 12.36 and 12.37 make internality and externality explicit analytical attributions. They do not imply that internal relations are stronger, more cooperative, more controllable, or more legitimate than external relations. Internal configurations can contain conflict, opacity, asymmetric authority, and weak coordination; external relations can be recurrent, trusted, highly integrated, or difficult to substitute. The distinction identifies where a relation sits relative to a selected boundary and what that position contributes to explanation.

Table 12.12 summarizes the principal dimensions developed in this section. The categories are illustrative and can overlap within a single empirical relation.

Proposition 12.38 (Boundary-relative internality). *The internal or external status of an economic relation is relative to the configuration, boundary, scale, and analytical purpose under study. A relation can be internal under one representation and external under another without contradiction when the relevant boundaries differ.*

Proposition 12.38 has methodological consequences. Empirical work should state the relevant boundary before interpreting internal or external effects, and compar-

Table 12.12: Selected dimensions of internal and external economic relations.

Dimension	Relational object	Illustrative analytical questions
Coordination	Alignment of activities, sequences, roles, and expectations within a selected configuration	Which mechanisms align interdependent activities, and where do coordination burdens accumulate?
Authority	Capacity to issue, interpret, delegate, or enforce decisions within the selected boundary	Which positions can commit resources or alter rules, and how is authority distributed or contested?
Resource flow	Movement and allocation of material, financial, temporal, infrastructural, or other resources	Which internal pathways enable or constrain productive and distributive processes?
Knowledge flow	Production, transmission, withholding, interpretation, and retention of economically relevant knowledge	Which actors know what, through which channels, and with what delay or distortion?
Trust and conflict	Expectations, reliance, disagreement, bargaining, and contestation within recurrent relations	Where does reliance reduce coordination burdens, and where do conflicts reveal divergent positions or interests?
Exchange	Cross-boundary transfer of goods, services, claims, rights, or other economically relevant objects	Which boundary-crossing transfers connect the configuration to external participants?
Cooperation and competition	Cross-boundary collaboration, rivalry, complementarity, and strategic interdependence	Which external relations expand capabilities, constrain alternatives, or reshape positions?
Regulation	Rules, oversight, classification, and enforcement originating outside the selected configuration	How do external rules enter internal procedures, capacities, costs, and responsibilities?
Mediation	Third-party structures that enable, filter, certify, finance, coordinate, or govern cross-boundary relations	Which intermediaries alter access, information, trust, bargaining, or dependence?
Coupling	Reciprocal influence between internal organization and external conditions	How do internal changes propagate outward, and how do external changes reorganize internal relations?

isons across studies should examine whether the studies use compatible boundaries. The proposition also discourages a simple identification of internality with control. Some processes represented inside an organization may be weakly governed, while formally external infrastructures, creditors, standards, platforms, or regulators can

exercise substantial influence over the feasible internal action space.

12.10.1 Internal Coordination

Internal coordination concerns the alignment of interdependent activities within a selected configuration. It can involve managerial direction, negotiated routines, schedules, workflow design, shared standards, information systems, professional norms, reciprocal adjustment, or combinations of these mechanisms. The analytical object is the relational architecture through which distributed activities become sufficiently coordinated for the configuration to reproduce or pursue a task.

The economic significance of internal coordination is well established in theories of the firm. Coase emphasized that some transactions are coordinated within firms because using the market mechanism itself can entail costs (Coase 1937). Williamson later analyzed governance structures as institutionally differentiated responses to transaction characteristics and contractual hazards (Williamson 2000). GRE can use these accounts without treating hierarchy or transaction-cost economizing as a complete explanation of internal coordination. Internal arrangements can also be shaped by learning, professional practice, technology, legal duties, care relations, political negotiation, organizational identity, and inherited routines.

Coordination can be centralized or distributed. A centralized schedule may sequence tasks through a designated authority; distributed teams may coordinate through protocols, shared information, mutual adjustment, or repeated interaction. Hybrid arrangements are common. A production system can combine managerial authority, algorithmic scheduling, peer coordination, professional discretion, and external standards. The relevant question is which relations coordinate which activities under the conditions being examined.

Internal coordination also has a temporal structure. Earlier commitments can create dependencies that constrain later sequencing. Delays in one component can propagate through others. Organizational memory, routines, technical standards, and accumulated expectations can make some coordination pathways easier to reproduce than alternatives. The resulting configuration can therefore display path dependence even when individual participants change.

Coordination quality remains dimension-specific. Tight synchronization can improve throughput while reducing local discretion; flexible decentralization can preserve adaptation while increasing negotiation burdens. GRE treats these consequences as empirical and evaluative questions whose significance depends on the practical problem and the positions affected.

12.10.2 Internal Authority

Internal authority concerns the capacity of positions within a selected configuration to make, interpret, delegate, revise, or enforce decisions that affect other internal positions. Authority can arise through law, ownership, employment, office, professional status, contract, technical control, expertise, customary recognition, or historically stabilized practice. Several sources of authority can coexist and can support or conflict with one another.

Formal authority and effective authority should be distinguished. An organizational chart can assign decision rights to one office while technical expertise, control

of information, budgetary discretion, access to infrastructure, or informal influence gives another actor substantial practical power. Conversely, a formally powerful position can depend on cooperation, implementation capacity, or external approval that limits its effective reach.

Authority is also object-specific. The capacity to allocate a budget does not necessarily confer authority over professional standards, personnel decisions, technical design, data access, or legal interpretation. Mapping internal authority therefore requires identifying the object of decision, the recognized source of authority, the mechanisms of implementation, and the avenues through which decisions can be questioned or revised.

Delegation creates further relational layers. A principal can authorize an agent, a board can delegate to management, management can delegate to units, and units can rely on technical systems or external contractors. Delegation can expand coordination capacity while distributing information and responsibility across several positions. The practical architecture of authority is therefore often recursive rather than reducible to a single chain of command.

Authority can be productive as well as restrictive. It can enable collective commitment, resolve coordination problems, allocate scarce resources, and support rapid response. It can also create dependence, suppress information, or concentrate the capacity to define relevant categories and priorities. Evaluation requires situated normative commitments and evidence about how authority operates in the configuration under study.

12.10.3 Internal Resource Flow

Internal resource flow concerns the movement, allocation, transformation, and retention of resources within a selected configuration. Relevant resources can include finance, materials, equipment, infrastructure, time, labor capacity, data, energy, access rights, attention, organizational support, and other objects that become economically consequential in the local process. Their internal movement can reveal capacities and constraints that aggregate resource totals conceal.

Resource flow is rarely neutral with respect to structure. Budget rules can privilege some units; technical architecture can make one team dependent on another; inventory practices can shift risk across locations; internal transfer rules can alter incentives; access controls can limit the convertibility of a nominal resource into effective capacity. A relational account therefore asks who can mobilize which resource, through which pathway, under what conditions, and with what residual obligations.

Internal allocation can occur through administrative decision, formula, negotiation, queue, entitlement, internal price, historical precedent, emergency priority, or decentralized request. Several mechanisms can operate simultaneously. Their interaction matters because the same nominal allocation can generate different capacities when access, timing, complementarities, or authority differ across positions.

Internal resource flows also connect to external relations. Revenue, credit, public funding, supplier inputs, infrastructure, household labor, ecosystem services, or data can enter the configuration from outside the selected boundary and be redistributed internally. Conversely, internal allocation choices can alter external demand, waste, emissions, employment, investment, or bargaining relations. Internal resource analysis therefore prepares the later study of internal–external coupling.

12.10.4 Internal Knowledge Flow

Internal knowledge flow concerns the production, transmission, interpretation, withholding, transformation, and retention of economically relevant knowledge within a configuration. Knowledge can concern tasks, technologies, demand, risk, regulations, relationships, local conditions, organizational history, tacit practice, or the state of the configuration itself. Its economic effects depend on who possesses it, whether it can be communicated, whether recipients can interpret it, and whether the institutional setting allows it to influence action.

Knowledge distribution is commonly uneven. Senior decision makers can possess broad strategic information while frontline participants hold detailed operational knowledge. Specialists can understand technical risks that are weakly legible to general managers. Local units can observe changing conditions before central reporting systems register them. The economic problem therefore includes both information transmission and the relation between different forms of knowledge.

Formal reporting systems can improve comparability and accountability, while classification and aggregation can compress local context. Informal communication can transmit tacit or rapidly changing information, while dependence on informal channels can create opacity or exclusion. The appropriate balance varies with the task, stakes, scale, and temporal conditions.

Knowledge can also be strategically withheld or selectively disclosed. Confidentiality, bargaining, organizational politics, professional boundaries, data governance, security concerns, and competition can all affect internal information pathways. These conditions make knowledge flow a relational question involving authority, incentives, trust, and responsibility as well as a technical question of communication capacity.

Organizational learning depends partly on whether experience leaves accessible traces. Records, routines, shared vocabularies, post-event review, technical repositories, personnel continuity, and institutional memory can preserve learning across changes in membership. Their presence does not guarantee learning: stored information can remain unused, misclassified, or detached from the contexts needed for interpretation. Knowledge flow should therefore be studied together with the relations that make knowledge actionable.

12.10.5 Internal Trust and Conflict

Internal trust and conflict describe two recurrent dimensions of relations among participants who remain connected within a selected configuration. Trust can support reliance under incomplete monitoring, facilitate information sharing, reduce verification burdens, and make coordination possible where contracts or rules leave substantial discretion. Conflict can disclose incompatible interests, divergent interpretations, distributional disputes, failures of recognition, or competing understandings of the configuration's purposes.

Trust is relational and domain-specific. Confidence in a colleague's technical competence does not imply confidence in their distributive judgment; confidence that an organization will pay contractual obligations does not imply confidence that it will protect every stakeholder interest. Trust can also become misplaced or structurally induced where exit is costly and participants have few alternatives. The analysis should therefore specify the object and conditions of reliance.

Conflict similarly admits several forms. Bargaining conflict can concern the distribution of resources; jurisdictional conflict can concern authority; epistemic conflict can concern interpretation or evidence; normative conflict can concern legitimate priorities; procedural conflict can concern how decisions are made. These forms can coexist. Their economic significance depends on how they affect coordination, investment, participation, learning, and later relation formation.

Trust and conflict can also interact. Established trust may allow disagreement without immediate dissolution of the relation. Repeated unresolved conflict can erode reliance, while contestation can sometimes reveal information that a highly conforming organization suppresses. Neither trust nor conflict therefore carries a fixed normative value within GRE. Their significance is assessed through the particular capacities, dependencies, protections, and histories involved.

Behavioral and institutional research on collective action illustrates the importance of reciprocity, reputation, and trust in sustaining cooperation under some conditions (Ostrom 1998). GRE treats such findings as situated evidence for particular mechanisms and leaves open how those mechanisms operate across other organizational and historical contexts.

12.10.6 External Exchange

External exchange concerns cross-boundary transfers through which a selected configuration acquires, provides, trades, licenses, lends, rents, or otherwise transfers economically relevant objects with external participants. The object can be a good, service, financial claim, right, data access, license, capacity, or other transferable or conditionally accessible resource. Exchange is one important form of external relation, though external relations also include regulation, cooperation, dependence, mediation, and non-contractual exposure.

Market exchange provides a familiar case, but a relational account examines more than the recorded transaction. Search, certification, reputation, standards, payment infrastructure, logistics, contract enforcement, credit, and prior relationships can condition whether exchange is possible and on what terms. Granovetter's account of embedded economic action provides a classic reminder that economic transactions occur within ongoing social structures rather than among wholly atomized actors (Granovetter 1985).

External exchange can reshape internal organization. A new supplier can require technical redesign; a financing contract can impose reporting duties; outsourcing can move activities across a formal boundary while increasing dependence on external coordination; a large customer can change production priorities or quality systems. Exchange therefore links the architecture on each side of the selected boundary.

The boundary itself can also change through repeated exchange. Long-term contracting, integration of information systems, dedicated assets, shared standards, or recurrent personnel interaction can make formally external partners functionally close to internal operations. Analysis should preserve the formal distinction where relevant while also representing the practical degree of coupling.

12.10.7 External Cooperation and Competition

External cooperation and competition concern relations among distinct configurations whose activities become strategically interdependent. Cooperation can include alliances, joint ventures, research collaboration, shared standards, mutual aid, purchasing consortia, interoperability arrangements, or collective governance. Competition can concern customers, inputs, labor, finance, legitimacy, intellectual resources, standards, policy influence, or positions within a broader field.

Cooperation and competition frequently coexist. Firms can collaborate on technical standards while competing in product markets; universities can share research infrastructure while competing for funding or personnel; jurisdictions can coordinate infrastructure while competing for investment. The relevant relation therefore cannot always be represented by a single cooperative or competitive label.

Interorganizational research provides evidence that collaboration can create learning opportunities and alter later network positions in some sectors (Powell et al. 1996). Network forms can also coordinate recurrent exchange through mechanisms distinct from both spot markets and administrative hierarchy (Powell 1990). GRE uses these findings as examples of how external relations can generate capacities and later opportunities while retaining attention to sectoral, institutional, and historical conditions.

Competition can likewise change relational architecture. Entry by a new competitor can alter supplier relations, labor demand, standards, investment, pricing practices, or alliance structures. Cooperative arrangements can generate exclusions or dependencies as well as shared capacity. Evaluation therefore requires analysis of which capacities and constraints are generated for differently positioned participants.

12.10.8 External Regulation

External regulation concerns rules, classifications, standards, oversight, adjudication, and enforcement originating in institutions represented outside the selected configuration but capable of altering its internal action space. Regulation can establish permissions, prohibitions, reporting duties, liability, eligibility, disclosure requirements, safety standards, labor protections, capital requirements, environmental conditions, or other constraints and capacities.

The external status of regulation is itself boundary-relative. A national regulator can be external to a firm while remaining internal to the national institutional configuration; a supranational rule can be external to a jurisdiction represented at one scale and internal to a larger legal order represented at another. Proposition 12.38 therefore applies directly to regulatory analysis.

Institutions shape interaction through rules and constraints that structure incentives and expectations (North 1990). In practice, external regulation commonly operates through internal translation. Organizations create compliance units, reporting routines, technical controls, documentation systems, training, or authorization processes that convert external rules into internal procedures. The effect of regulation therefore depends partly on the internal relations through which it is interpreted and implemented.

Regulation can also generate capacities. Certification can support trust; common

standards can enable interoperability; legal recognition can make claims enforceable; reporting requirements can create information infrastructures; prudential rules can support system resilience under some conditions. These effects should be examined empirically alongside compliance costs, distributional consequences, strategic responses, and possible regulatory gaps.

12.10.9 External Mediation

External mediation concerns third parties and infrastructures that enable, filter, certify, finance, coordinate, or govern relations across a selected boundary. Banks, exchanges, platforms, brokers, auditors, insurers, rating systems, standards bodies, payment networks, logistics providers, professional intermediaries, and public agencies can perform mediating functions. The relevant category depends on the mechanism under study and is not limited to commercial intermediation.

Mediators can reduce coordination burdens by matching participants, standardizing information, verifying identity or quality, pooling risk, settling payments, resolving disputes, or providing common infrastructure. They can also become gatekeepers when access to a relation depends on their classifications, technical interfaces, approval, pricing, or data. Mediation therefore alters the relational conditions under which otherwise external parties encounter one another.

A mediator's formal independence does not imply weak influence. Control over standards, rankings, search visibility, credit assessment, payment access, certification, or technical protocols can shape the feasible actions of participants without transferring formal ownership or managerial authority. Conversely, participants can sometimes discipline mediators through competition, governance rights, regulation, collective action, or technical alternatives. The resulting structure is an empirical question.

Mediation can also blur organizational boundaries. A platform can coordinate transactions among legally separate participants through common rules and technical architecture; a lead firm can coordinate suppliers through standards and information systems; an auditor can connect internal reporting to external investors and regulators. Such arrangements illustrate why economic boundary analysis should track effective relational pathways in addition to formal legal categories.

12.10.10 Internal–External Coupling

Internal–external coupling concerns the reciprocal pathways through which changes inside a selected configuration alter external relations and external changes reorganize internal relations. Coupling is therefore a property of the interaction between boundary-relative domains rather than an assertion that the boundary disappears. A boundary can remain legally or analytically useful while substantial causal influence crosses it.

External demand can alter internal production and staffing; credit conditions can change investment and governance; regulation can reorganize reporting and authority; supplier disruptions can change inventory strategy; technological standards can reshape internal architecture; labor-market conditions can alter bargaining and retention. Internal decisions can in turn affect prices, suppliers, workers, communities,

infrastructures, public budgets, ecological conditions, and the formation of later external relations.

Coupling can be weak, strong, asymmetric, delayed, or nonlinear. A configuration may depend heavily on one external infrastructure while exercising little influence over it. Another may shape the rules or standards on which many external participants depend. Some effects become visible quickly, while others accumulate through investment, learning, reputation, environmental change, institutional response, or path-dependent technical adoption.

Proposition 12.39 (Internal–external coupling). *Where a selected economic boundary is crossed by recurrent flows of resources, knowledge, authority, rules, obligations, or consequences, internal and external relations can become jointly constitutive of the configuration’s practical capacities. Explanatory adequacy then requires representing the cross-boundary mechanisms relevant to the target process while retaining a boundary resolution appropriate to the inquiry.*

Proposition 12.39 avoids two opposite simplifications. Treating the configuration as closed can omit external conditions on which its internal capacities depend. Expanding the boundary to include every causal influence can make the unit analytically unmanageable. GRE therefore treats boundary selection as a revisable modeling decision and asks whether omitted cross-boundary relations materially alter the explanation.

Internal–external coupling can also transform the boundary over time. Repeated outsourcing can externalize activities once treated as internal; vertical integration can internalize recurrent exchange; platform architecture can create new quasi-internal coordination among legally separate participants; regulatory reform can relocate responsibilities; technological interoperability can connect previously separated systems. The internal–external distinction therefore has a history as well as a scale.

Remark 12.40 (Boundary-relative coupling). Claims about internal or external effects should identify the boundary and scale to which the claim refers. Where conclusions change materially under another plausible boundary, that sensitivity is itself economically informative and may warrant comparison across representations.

The distinction developed in this section provides a basis for analyzing organizations as configurations that condense multiple internal relations while remaining constituted through external relations. The next section examines organizational emergence, roles, authority, coordination, memory, learning, and generativity with this boundary-relative architecture in view.

12.11 Organizations as Relational Condensations

Organizations occupy a distinctive position in economic architecture because they can stabilize memberships, roles, authority relations, coordination practices, resource commitments, knowledge pathways, records, and external interfaces across histories that outlast particular transactions or participants. This section develops organizations as *relational condensations*: comparatively stabilized configurations in which heterogeneous economic relations become sufficiently concentrated, differentiated, and reproducible to support organized capacities over time. Its objective is to clarify organizational emergence, membership, roles, authority, coordination, inter-

nal differentiation, external mediation, memory, learning, and generativity without reducing an organization either to its legal shell or to the aggregate properties of its members. The discussion is relational and historical. It treats organizational form as a revisable analytical attribution whose explanatory value depends on the mechanisms under study, while legal, accounting, technical, spatial, and social boundaries remain empirically distinguishable.

Economic thought has long treated organizations as analytically significant forms of coordination. Coase's account of the firm emphasized that some activities are coordinated within firms because reliance on market exchange itself can involve costs (Coase 1937). Organizational law can also stabilize legally recognized entities and partition assets and claims in ways that give organizational boundaries material economic consequences (Hansmann and Kraakman 2000). Other arrangements, including networks and interorganizational collaborations, show that economically consequential coordination can extend across formal organizational boundaries (Powell 1990; Powell et al. 1996). GRE uses these traditions as complementary reference points. The present concept of relational condensation is intended to identify the patterned concentration and reproduction of relations that can make an organization economically consequential, while leaving open which mechanisms dominate in a particular case.

Definition 12.41 (Organizational relational condensation). For a specified analytical purpose and time horizon, an *organizational relational condensation* is a comparatively stabilized configuration in which memberships, roles, authority relations, coordination practices, resource commitments, knowledge pathways, records, and external interfaces are sufficiently organized to reproduce selected collective capacities or activities across changing events and participants. The relevant dimensions of condensation are empirical and need not coincide with a single legal, spatial, or technical boundary.

Definition 12.41 uses condensation as an analytical metaphor for relative concentration and stabilization. It does not imply immobility, closure, hierarchy, or normative desirability. A loosely coupled association can be organizationally consequential where recurrent roles, shared records, standards, and external recognition stabilize coordination. A formally incorporated entity can remain weakly condensed where authority, knowledge, resources, or participation are fragmented. Organizational analysis therefore requires attention to the dimensions through which the configuration is reproduced.

Table 12.13 summarizes the principal dimensions developed in this section. The dimensions are illustrative and can vary independently.

Proposition 12.42 (Dimension-relative organizational condensation). *The degree and form of organizational condensation are relative to the dimensions and time horizon selected for analysis. Strong stabilization of legal identity or authority can coexist with weak stabilization of membership, knowledge, routines, or external interfaces, and the reverse can also occur.*

Proposition 12.42 prevents organizational analysis from collapsing several distinct forms of persistence into one variable. An organization can maintain legal continuity through extensive personnel turnover, preserve routines while authority changes, retain a recognizable public identity while internal coordination fragments, or remain operationally integrated despite distributed legal entities. Empirical claims about organizational persistence should therefore specify what is persisting and through

Table 12.13: Selected dimensions of organizations as relational condensations.

Dimension	Relational object	Illustrative analytical questions
Emergence	Stabilization of recurring relations into an organizational configuration	Which interactions, commitments, rules, assets, or recognitions make organized activity reproducible?
Membership	Conditions linking participants to organizational rights, duties, access, exposure, and exit	Who participates in which capacity, and how do formal and effective memberships differ?
Roles	Recurrent positions carrying differentiated expectations, competencies, permissions, or obligations	Which activities and responsibilities are attached to positions rather than particular persons?
Authority	Relations through which some positions can commit resources, issue decisions, interpret rules, or coordinate others	How is authority constituted, delegated, contested, constrained, or redistributed?
Coordination	Mechanisms that align differentiated and interdependent activities	Which routines, standards, schedules, negotiations, or information systems produce workable joint activity?
Differentiation	Internal distribution of functions, knowledge, resources, status, exposure, and responsibility	Which internal distinctions generate specialization, complementarity, hierarchy, or fragmentation?
External mediation	Interfaces linking the organization to markets, institutions, networks, infrastructures, and publics	Which boundary positions translate, filter, certify, negotiate, or transmit external conditions?
Memory	Persistence of records, routines, artefacts, infrastructures, and interpretive conventions	Which past decisions and practices remain available to condition later organizational action?
Learning	Revision of routines, representations, roles, and coordination in response to experience or inquiry	What changes, who can authorize change, and which prior commitments constrain adaptation?
Generativity	Organizational production of later capacities, relations, subjects, institutions, and possibilities	What does the organization make easier, harder, thinkable, legitimate, or reproducible over time?

which mechanisms.

12.11.1 Organizational Emergence

Organizational emergence concerns the historical stabilization of relations into a configuration capable of reproducing selected activities or commitments beyond isolated transactions. Emergence can involve incorporation, association, recurrent contracting, shared infrastructure, pooled resources, role differentiation, rule formation, recognition by external institutions, or repeated coordination. The relevant mechanism can differ substantially across firms, cooperatives, public bodies, voluntary associations, research organizations, platform operators, and other organizational forms.

A relational account therefore treats organizational emergence as a process of selective stabilization. Repeated interaction alone need not create an organization. What matters is whether some combination of membership, authority, roles, resources, records, expectations, or external recognition becomes sufficiently durable to condition later action. Coase's theory identifies one important economic mechanism through which coordination can become internalized within a firm (Coase 1937). Network forms analyzed by Powell illustrate that persistent coordination can also develop through recurrent reciprocal relations that do not reduce to either spot-market exchange or unified hierarchy (Powell 1990). GRE leaves room for both patterns and for other empirically grounded mechanisms.

Organizational emergence can be gradual or event-concentrated. A group may accumulate routines and shared resources before receiving legal recognition; a new legal entity may be created quickly while operational capacities remain under construction. Merger, spin-off, public authorization, platform launch, emergency mobilization, or collective self-organization can create different temporal sequences. The order of these events can matter because earlier commitments shape later membership, trust, asset control, authority, and external expectations.

Emergence also has a boundary dimension. Some organizations are constituted through relatively clear legal membership and asset boundaries; others depend on contractors, volunteers, affiliated units, shared infrastructure, or external communities that are operationally important despite weaker formal inclusion. Organizational emergence should therefore be reconstructed through the relations that generate effective coordinated capacity rather than inferred solely from a date of incorporation or formal chart.

12.11.2 Membership

Organizational membership specifies relations through which subjects or entities acquire positions, rights, duties, access, exposure, recognition, or participation within an organizational configuration. Membership can be legal, contractual, professional, functional, representational, voluntary, customary, technical, or informal. These forms can overlap while carrying different practical consequences.

The analysis developed for economic boundaries and membership remains important here. Formal membership may provide voting rights, employment status, access to records, benefit eligibility, or fiduciary duties, while effective participation can depend on information, schedules, language, professional standing, technical access, or informal acceptance. Conversely, actors formally outside the organization can remain economically entangled through subcontracting, franchising, financing,

platform dependence, family relations, or shared infrastructure.

Membership can also be layered. A person can belong to a team, profession, union, project, subsidiary, and parent organization simultaneously, with partly different obligations and channels of representation. Organizational decisions can therefore affect members through several overlapping positions. Analysis should identify which membership relation is relevant to the mechanism being studied rather than assigning one total organizational status to the subject.

Entry and exit shape organizational generativity. Recruitment, admission, promotion, affiliation, dismissal, retirement, resignation, and transfer alter the composition of capacities and relations. Practical exit can differ from formal exit where pensions, confidentiality obligations, debt, reputational effects, data retention, professional networks, or dependency continue after membership ends. Membership is thus an event-ordered relation with a possible economic afterlife.

12.11.3 Roles

Organizational roles are recurrent relational positions to which activities, expectations, competencies, permissions, obligations, or representational functions are attached. Roles make some aspects of coordinated action portable across changes in personnel: a new treasurer, laboratory manager, nurse, engineer, auditor, or committee chair can inherit selected responsibilities without reproducing the predecessor's full history or identity.

Role stabilization supports continuity but can also simplify heterogeneous subjects. Formal descriptions often compress tacit practice, emotional labor, informal mediation, care, troubleshooting, and accumulated local knowledge. The effective role enacted in practice can therefore exceed the role described in contracts or charts. Empirical analysis should compare formal assignment with observed responsibilities, dependencies, information access, and expectations where those differences matter.

Roles can be complementary, overlapping, conflicting, or vacant. Complementarity allows specialization; overlap can provide redundancy or create ambiguity; conflict can arise when several roles impose incompatible obligations; vacancy can interrupt coordination even where the formal organizational entity remains intact. Role architecture therefore influences both capacity and vulnerability.

Roles also mediate responsibility. A decision can be organizationally attributed while its preparation, authorization, execution, and oversight are distributed across several roles. Clear role specification may improve traceability, yet elaborate division of labor can also diffuse responsibility. GRE therefore treats role differentiation as an empirical architecture of action and accountability rather than as automatic evidence of either efficiency or irresponsibility.

12.11.4 Authority

Organizational authority concerns relations through which some positions can commit resources, issue or interpret decisions, define procedures, assign tasks, evaluate performance, represent the organization, or alter the feasible actions of other participants. Authority can be constituted through law, ownership, contract, professional expertise, appointment, election, technical control, control of information, convention, or combinations of these sources.

Formal and effective authority can diverge. A formally senior office may depend on technical specialists for operational judgment; a platform administrator can shape feasible action through software permissions; a finance unit can constrain projects through budget control; an informal coordinator can become central because others rely on accumulated knowledge. Organizational analysis should therefore identify the mechanisms through which authority becomes effective rather than infer control directly from title or legal status.

Authority can be delegated and nested. Boards delegate to executives, executives to managers, managers to teams, and organizations can delegate selected functions to contractors, algorithms, committees, or professional bodies. Delegation creates relations among authorization, discretion, monitoring, and responsibility. It can expand organizational capacity by distributing judgment, while also creating information asymmetries and ambiguity concerning accountability.

Authority is also historically revisable. Crisis, growth, technological change, regulatory reform, professionalization, or repeated coordination failure can redistribute authority. Temporary emergency powers can persist beyond the conditions that produced them; informal authority can become formalized; centralized control can be decentralized. These possibilities make the reproduction and transformation of authority part of organizational history rather than a fixed structural parameter.

12.11.5 Coordination

Organizational coordination aligns interdependent activities across roles, resources, time, and information. It can rely on managerial direction, schedules, routines, protocols, prices used internally, professional norms, meetings, digital systems, reciprocal adjustment, shared objectives, or negotiated conventions. Several mechanisms commonly coexist within the same organization.

Coordination creates economic capacity where differentiated activities need to occur in compatible sequences or combinations. A hospital, research laboratory, manufacturing facility, public agency, or software organization depends on specialized contributions whose value can depend on timing and mutual adjustment. The organizational problem therefore includes alignment as well as resource possession.

Information and attention constrain coordination. Simon's analysis of organizations in information-rich environments emphasizes that abundant information can make recipient attention scarce, making the allocation of attention an organizational design problem (Simon 1971). GRE extends this concern relationally: who receives which information, in what representation, with what authority to act, and at what point in a process can shape the practical effect of knowledge.

Coordination can become over-stabilized as well as under-stabilized. Highly routinized arrangements may support reliability under recurrent conditions while making unusual signals harder to interpret or act upon. Looser arrangements can support local adaptation while increasing negotiation burdens or inconsistency. The relevant balance is problem-dependent and can change with scale, uncertainty, technology, and the history of the organization.

12.11.6 Internal Differentiation

Internal differentiation concerns the patterned distribution of functions, knowledge, resources, authority, status, exposure, and responsibility within an organization. Differentiation can create specialization and complementarity, but it can also generate internal boundaries, unequal dependencies, communication burdens, and divergent perspectives on organizational problems.

Functional differentiation assigns distinct tasks to units or roles. Hierarchical differentiation distributes authority across levels. Professional differentiation can create communities with their own standards and epistemic practices. Spatial and technical differentiation can separate sites, systems, or infrastructures. Financial differentiation can allocate budgets and performance responsibilities to units. These dimensions may overlap without forming one simple hierarchy.

Differentiation changes what the organization can know about itself. Local units can hold detailed situated knowledge that is difficult to aggregate; central units can observe cross-unit patterns that remain invisible locally. Reporting systems, metrics, meetings, audits, and digital traces mediate between these perspectives. Their representations can support coordination while also compressing local context. Organizational self-knowledge is therefore produced through a relational architecture of observation and representation.

Differentiation also shapes exposure. Some units can absorb volatility, delay, or compliance burdens on behalf of others; frontline roles can encounter risks generated by decisions elsewhere; support functions can become invisible despite their importance to organizational continuity. Aggregate organizational performance can therefore coexist with heterogeneous internal experiences and capacities. GRE retains these internal distributions when they are relevant to explanation or evaluation.

12.11.7 External Mediation

Organizations interact with external economic configurations through mediated interfaces. Sales teams, procurement units, legal departments, public-affairs offices, standards specialists, auditors, recruiters, banks, logistics providers, platforms, professional associations, and other boundary positions can translate between internal organization and external markets, institutions, networks, infrastructures, and publics.

External mediation involves more than transmission. Mediators can classify opportunities, filter information, certify compliance, negotiate commitments, interpret rules, sequence access, and transform external signals into internal decisions. They can therefore affect which external relations become organizationally visible and actionable. A regulator's rule, market price, scientific finding, community concern, or supplier constraint acquires organizational consequences through particular channels of reception and interpretation.

Organizations can also depend on external mediators that they do not control. Credit-rating agencies, payment infrastructures, cloud providers, certification bodies, dominant platforms, or professional gatekeepers can condition organizational access and feasible action. Formal externality therefore does not imply weak influence. The internal-external coupling developed in Section 12.10 remains central to

organizational analysis.

Interorganizational networks can themselves become sites of learning and innovation. Powell, Koput, and Smith-Doerr's study of biotechnology emphasizes the importance of networks of collaboration for learning and innovation (Powell et al. 1996). Such cases caution against representing organizational capacity as wholly contained inside the organization's formal boundary. Some capacities are generated through durable external relations and shared infrastructures.

12.11.8 Organizational Memory

Organizational memory concerns the persistence of economically relevant traces of prior activity that can condition later organizational action. Memory can be carried by records, routines, standards, contracts, software, physical layouts, technical artefacts, archives, narratives, role expectations, professional practice, and the embodied knowledge of participants. These carriers differ in durability, accessibility, interpretability, and transferability.

Memory is selective. Organizations record some events and omit others; metrics preserve some dimensions and compress others; staff turnover can remove tacit knowledge while leaving formal procedures intact. Archive and record systems can preserve decisions without preserving the practical context through which those decisions became meaningful. Organizational memory should therefore be treated as a historically produced representation of prior activity rather than as a complete store of the past.

Routines are an important carrier of organizational continuity. Nelson and Winter's evolutionary analysis emphasizes routines, search, and organizational change as central to the dynamics of firms and industries (Nelson and Winter 1982). Within GRE, routines can be analyzed as recurrent relational patterns that preserve selected ways of coordinating, interpreting, and acting. Their persistence can support reliability and accumulated capability while also carrying assumptions formed under earlier conditions.

Memory can be distributed across internal and external infrastructures. Contractors, regulators, standards bodies, customers, suppliers, former members, and technical systems can retain records or expectations that shape later organizational action. An organization can therefore lose internal memory while remaining constrained by external traces of its history.

12.11.9 Organizational Learning

Organizational learning concerns changes in routines, representations, roles, coordination practices, resource commitments, or interpretive frames that arise through experience, inquiry, interaction, or deliberate experimentation. Learning is organizationally significant when these changes become sufficiently embedded to influence later action beyond the cognition of a single participant.

Learning can occur through several pathways. Organizations can revise procedures after failure, incorporate external knowledge through recruitment or collaboration, experiment with alternative routines, update models after new evidence, or redistribute authority when existing channels prove inadequate. Learning can also occur through imitation, regulation, professional standards, and interorganizational

networks. The relevant mechanism should be specified rather than inferred merely from observed change.

Learning can be uneven. One unit can revise while another preserves older routines; formal policy can change without practical implementation; individuals can learn while the organization fails to retain their knowledge; an organization can reproduce a new procedure without understanding the conditions under which it works. Organizational learning therefore has dimensions of acquisition, interpretation, retention, dissemination, and enactment that may diverge.

Learning also changes the object that future evidence addresses. Once routines, roles, technologies, or relationships have changed, evidence generated under the earlier organizational configuration may have limited transportability. Learning can therefore require continued observation of the reorganized system rather than treating the adopted lesson as permanently valid. This is especially important under rapidly changing or high-uncertainty conditions.

Remark 12.43 (Learning and retained revisability). Organizational learning is treated here as a historically situated capacity for revision rather than as monotonic improvement. A newly adopted routine or representation can later prove inadequate, and an organization can learn in ways that expand some capacities while reducing others. Claims of learning should therefore identify the changed object, the evidence of changed practice, and the relevant consequences.

12.11.10 Organizational Generativity

Organizational generativity concerns the ways organizational configurations participate in producing later capacities, relations, subjects, institutions, representations, and fields of possibility. Organizations do more than coordinate existing resources. They can train participants, stabilize professions, create technical standards, accumulate infrastructures, generate classifications, produce knowledge, establish reputations, form dependencies, alter markets, and reshape the conditions under which later organizations and subjects act.

Generativity can operate internally and externally. Internally, organizations can develop skills, routines, identities, authority structures, and technological capacities. Externally, they can create supply systems, standards, employment pathways, professional communities, contractual expectations, public categories, and infrastructural dependencies. These effects can persist after particular projects or memberships end.

Generativity also carries heterogeneous consequences. An organization can expand productive or epistemic capacity while concentrating authority, generating dependency, externalizing risk, narrowing alternatives, or reproducing exclusions. GRE therefore separates the descriptive claim that a configuration generates later possibilities from the normative evaluation of those possibilities. The same generative process can affect differently situated participants in different ways.

Organizational generativity is history-dependent. Capabilities accumulated through earlier projects can support later innovation; reputational history can open or close partnerships; prior failures can reshape monitoring and authority; accumulated infrastructure can create path dependence; repeated classifications can stabilize categories that later actors inherit. Organizational history therefore enters future economic possibility through both material and relational carriers.

Proposition 12.44 (Organizational generativity beyond formal boundaries). *Where organizational activity changes capacities, relations, expectations, infrastructures, classifications, or dependencies outside the organization's selected formal boundary, analysis of organizational generativity may require a wider impact boundary than analysis of organizational membership or legal identity.*

Proposition 12.44 preserves the boundary discipline developed earlier in the chapter. It does not imply that every indirect consequence should be attributed to the organization. The relevant impact boundary should be justified by an identifiable mechanism and appropriate evidence. The proposition instead recognizes that organizations can be causally consequential through supply chains, labor markets, knowledge networks, standards, infrastructures, communities, and institutions that extend beyond formal membership.

Remark 12.45 (Organizations as revisable analytical condensations). The language of relational condensation is a heuristic for studying comparative stabilization and organized capacity. Where another representation better explains the relevant process—for example a network, institution, platform ecosystem, project coalition, or distributed infrastructure—GRE permits the organizational representation to be revised rather than treating organizational form as the privileged unit of analysis.

Organizations thus provide one comparatively stabilized form through which economic relations can be coordinated, remembered, learned, and made generative across time. Their capacities depend partly on rules and classificatory structures that can persist beyond particular organizations and condition many organizations simultaneously. These wider structures motivate analysis of institutions as relational infrastructure whose effects can extend across many organizational configurations.

12.12 Institutions as Relational Infrastructure

Institutions contribute to economic architecture by stabilizing recurrent conditions under which actors recognize positions, interpret conduct, form expectations, allocate authority, record entitlements, resolve disputes, and reproduce or revise rules. This section develops institutions as *relational infrastructure*: historically constituted configurations of formal rules, informal rules, norms, legal and administrative structures, classifications, expectations, records, and practices that condition recurring economic relations across events and, often, across organizational boundaries. Its objective is to distinguish institutional structure from particular organizations while clarifying the mechanisms through which institutions acquire practical economic effects. The discussion is relational and historical. It treats institutional infrastructure as an analytical representation whose relevant components, boundaries, and durability depend on the inquiry, and whose reproduction can include reinterpretation, selective enforcement, contestation, and transformation.

Institutional economics provides several useful starting points for this analysis. North characterizes institutions as humanly devised constraints that structure interaction and shape incentives, while distinguishing institutions from organizations that operate within and act upon institutional environments (North 1990). Ostrom's work shows that institutional arrangements can be diverse, locally organized, layered, and dynamically revised rather than reducible to a single state-market opposition (Ostrom 1990; Ostrom 2005). Sociological and legal traditions add further dimensions: so-

cial norms can depend on expectations and conditional compliance (Bicchieri 2006); legal orders combine different kinds of rules and practices of recognition (H. L. A. Hart 2012); and classifications and standards can organize visibility, comparability, and action in ways that become infrastructural precisely because they are routinely embedded in practice (Bowker and Star 1999; Desrosières 1998). GRE draws on these traditions without treating any one institutional definition as exhaustive.

Definition 12.46 (Institutional relational infrastructure). For a specified economic inquiry and time horizon, *institutional relational infrastructure* is the comparatively stabilized configuration of rules, norms, recognized positions, classifications, procedures, expectations, records, enforcement capacities, and interpretive practices that conditions recurrent economic relations and their possible continuation or revision. Its components can be formal or informal, distributed across multiple organizations, and unevenly enacted across positions and settings.

Definition 12.46 uses infrastructure in a relational sense. The term points to recurrent conditions that make some actions, claims, classifications, and expectations easier to reproduce while constraining or redirecting others. It does not imply that institutions are fixed, hidden, neutral, or merely enabling. Institutions can become explicit objects of contestation, can distribute costs and capacities unevenly, and can be transformed through both formal reform and changes in interpretation or practice.

A second distinction concerns institutions and organizations. Organizations can possess members, offices, assets, procedures, and decision capacities. Institutions can structure the relations through which organizations and other actors operate, yet the two categories can overlap empirically. Courts, ministries, firms, universities, professional associations, standard-setting bodies, and community organizations can simultaneously be organizations and important sites of institutional reproduction. Their organizational continuity, however, should not be equated with the continuity of the institutions they enact.

Proposition 12.47 (Institution–organization non-equivalence). *Institutional persistence and organizational persistence are analytically separable. An institution can continue through organizational replacement or dispersion across several organizations, while an organization can persist through substantial change in the rules, norms, classifications, or expectations through which its economic relations are constituted.*

Proposition 12.47 makes the unit of analysis explicit. A property regime, accounting convention, licensing rule, professional norm, procurement practice, market classification, or welfare entitlement can survive changes in the organizations administering it. Conversely, the same organization can undergo institutional transformation when its operative rules, interpretive conventions, classifications, or recognized positions change.

Table 12.14 summarizes the principal dimensions developed in this section. The dimensions are illustrative and can overlap within the same institutional configuration.

12.12.1 Formal Rules

Formal rules are codified prescriptions, permissions, prohibitions, procedures, eligibility conditions, and decision criteria that receive recognized standing within an institutional order. They can appear in legislation, regulation, contracts, constitutions,

Table 12.14: Selected dimensions of institutional relational infrastructure.

Dimension	Relational object	Illustrative analytical questions
Formal rules	Codified prescriptions, permissions, procedures, and conditions	Which recognized rules structure access, obligation, authority, transfer, or sanction?
Informal rules	Recurrent practical conventions and expectations without full codification	Which unwritten practices condition what participants regard as feasible, expected, or acceptable?
Norms	Socially sustained expectations carrying evaluative or sanctioning force	Whose expectations matter, under what conditions, and how is compliance produced or contested?
Legal structures	Rights, duties, powers, liabilities, statuses, and procedures backed by legal institutions	How do legal relations constitute positions, entitlements, authority, and enforceable claims?
Administrative structures	Procedures, offices, records, eligibility rules, and implementation routines	How are general rules translated into recurring decisions and material access?
Classification systems	Categories that sort persons, entities, activities, resources, and events	Which distinctions become visible, comparable, eligible, taxable, reportable, or governable?
Expectations	Anticipations concerning conduct, enforcement, continuity, and others' responses	Which expectations coordinate action, and how can expectations become self-reinforcing or destabilized?
Memory	Records, precedents, routines, archives, infrastructures, and retained interpretive conventions	Which past decisions remain available to condition later institutional action?
Reproduction	Recurring enactment, interpretation, compliance, enforcement, teaching, and recording	Through which practices is an institution maintained or altered across events?
Change	Revision of rules, categories, expectations, practices, enforcement, or recognized positions	Which changes modify the operative relational infrastructure and which remain nominal?

organizational statutes, technical standards, accounting frameworks, benefit rules, procurement procedures, or other documentary forms. Their economic importance arises partly from the relations they authorize, restrict, classify, or make enforceable.

A relational account distinguishes the textual existence of a rule from its enacted effects. The same formal rule can be interpreted differently across offices, jurisdictions,

industries, or historical periods. Its operation can depend on administrative capacity, information, resources, recognized authority, enforcement, professional judgment, technological systems, and the responses of affected actors. Formal codification therefore provides an important source of institutional stabilization without producing a mechanically self-applying economic order.

Hart's analysis of legal systems is useful for distinguishing rules that govern conduct from rules concerning recognition, change, and adjudication (H. L. A. Hart 2012). In economic settings, analogous distinctions can matter because rules that define a transaction, entitlement, organizational status, reporting obligation, or licensing condition often coexist with rules specifying who may alter, interpret, certify, or enforce those arrangements. Institutional analysis therefore benefits from asking both what the formal rule states and how authority over the rule is relationally organized.

Remark 12.48 (Rule text and enacted rule). For empirical purposes, a formal rule can be represented through at least two analytically distinguishable objects: its documented formulation and its recurrent enactment in practice. Their divergence can itself become economically consequential.

12.12.2 Informal Rules

Informal rules are recurrent practical conventions, expectations, and understandings that guide conduct without being fully codified in authoritative form. They can concern bargaining, reciprocity, seniority, hiring, promotion, payment timing, professional conduct, access to information, acceptable negotiation, conflict handling, or the practical interpretation of formal procedures. Their economic relevance can become substantial when actors coordinate around them, expect others to follow them, or anticipate costs from violation.

Informality should not be equated with weakness. Some informal practices can be highly persistent and widely recognized; some formal rules can be weakly enacted. The analytical question concerns the mechanisms through which a practical regularity becomes consequential. Repetition, mutual expectation, reputation, social sanction, professional identity, dependency, local knowledge, and complementarity with formal arrangements can each contribute.

Informal rules can also modify the operation of formal institutions. A formally open application procedure can coexist with informal gatekeeping. A formal reporting requirement can be shaped by tacit conventions about what counts as a problem worth escalating. A formal market can rely on informal trust and reputational expectations. These interactions make institutional configurations difficult to understand through documentary rules alone.

12.12.3 Norms

Norms are socially sustained expectations concerning appropriate, obligatory, permissible, or disapproved conduct. In economic life they can shape repayment, reciprocity, workplace conduct, professional responsibility, care obligations, acceptable profit-seeking, disclosure, stewardship, consumption, or participation in collective arrangements. Normative force can arise through internalized commitments, anticipated sanctions, expectations about others, identity, reputation, or combinations of these mechanisms.

Bicchieri's analysis is useful because it relates norm compliance to empirical and normative expectations rather than treating norms as undifferentiated cultural background (Bicchieri 2006). GRE retains this mechanism-sensitive orientation while allowing that norms can operate through heterogeneous pathways in different settings. A norm can be widely stated but weakly enacted, locally powerful but institutionally unrecognized, or internally contested among differently positioned participants.

Norms also require scope discipline. Describing a recurrent expectation does not establish its ethical legitimacy. A norm can coordinate valuable cooperation, stabilize exclusion, reproduce hierarchy, protect vulnerable participants, or combine these effects across different positions. Normative desirability therefore remains a separate inquiry from institutional persistence or causal efficacy.

Remark 12.49 (Normative persistence and evaluation). The persistence of a norm is evidence about institutional reproduction, not by itself evidence that the norm should be preserved. GRE keeps descriptive, causal, and normative analyses distinguishable even when they concern the same institutional relation.

12.12.4 Legal Structures

Legal structures organize economic relations through recognized statuses, rights, duties, powers, liabilities, procedures, and remedies. Property, contract, corporate form, insolvency, taxation, labor status, licensing, trust, public authority, and regulatory obligations can each alter who may act, who may exclude, who bears liability, which claims survive organizational change, and how disputes are resolved. Legal structure is therefore economically constitutive in many settings rather than merely an external constraint upon already formed market relations.

Hohfeld's decomposition of legal positions into correlatives such as rights and duties and into powers, liabilities, privileges, and immunities illustrates the value of treating law relationally (Hohfeld 1919). Organizational law provides a concrete economic example: legal forms can partition assets and claims, thereby altering the relations among owners, managers, organizational creditors, and personal creditors (Hansmann and Kraakman 2000). These legal arrangements can stabilize economic entities and transactions while remaining historically revisable.

Legal structure should nevertheless be distinguished from enacted relational structure. Formal law can be interpreted, mediated, selectively enforced, strategically used, or partially displaced by social ordering. Moore's account of semi-autonomous social fields is relevant here because it shows how social fields can generate rules and induce compliance while remaining embedded in wider legal environments (S. F. Moore 1973). The empirical effect of law can therefore depend on its interaction with organizations, administrative practices, social expectations, and material capacities.

12.12.5 Administrative Structures

Administrative structures translate general institutional commitments into recurrent procedures, records, determinations, permissions, classifications, payments, inspections, and sanctions. Offices, forms, databases, review procedures, eligibility criteria, reporting systems, professional roles, and implementation routines can determine whether a nominal right or obligation becomes practically accessible and how consistently it is applied.

This translation can have independent economic significance. Two jurisdictions can share similar statutory language while producing different practical access because administrative capacity, documentation requirements, discretion, information systems, staffing, or appeal procedures differ. Within one jurisdiction, actors can experience the same nominal institution differently because their ability to navigate administrative structures is unequal.

Administrative structures also generate evidence. Records created for taxation, benefits, licensing, inspection, or service delivery can later become data through which institutions understand the populations and activities they govern. Such records can improve observability, yet their categories and collection procedures also shape what becomes visible. The informational function of administration is therefore connected to the classification systems considered below.

12.12.6 Classification Systems

Classification systems sort persons, organizations, activities, resources, transactions, risks, occupations, industries, jurisdictions, or events into categories that can be recognized and acted upon. Economically consequential classifications include employment status, corporate form, tax category, eligibility class, accounting item, industrial sector, credit category, property type, residency status, and numerous administrative or technical classifications.

Classification can make heterogeneous cases comparable enough for recurrent institutional action. Statistical histories analyzed by Desrosières show how coding, aggregation, and categories participate in the construction of standardized objects of quantitative knowledge (Desrosières 1998). Bowker and Star similarly emphasize that classifications and standards can become embedded infrastructures that shape visibility and interaction (Bowker and Star 1999). In GRE, this means classification is potentially both epistemic and practical: it can describe an economic configuration while also modifying access, obligations, recognition, prices, monitoring, or organizational responses.

The consequences of classification depend on where the category is used and what relations it activates. The same label can be descriptive in one setting and eligibility-determining in another. Classification can improve coordination and reduce ambiguity, while also compressing heterogeneity, producing boundary cases, or creating incentives to reorganize behavior around the category. The category's practical effects therefore require empirical tracing.

Proposition 12.50 (Institutional classification as a potentially performative relation). *When a classification changes recognized status, access, obligation, authority, evaluation, or anticipated response, the act of classification can become part of the economic relation it represents. The strength and direction of this performative effect remain empirical questions.*

Proposition 12.50 is intentionally conditional. Many classifications remain primarily descriptive. Others become consequential because organizations, markets, public authorities, or participants act upon them. The relevant inquiry concerns the pathway through which representation enters later events.

12.12.7 Expectations

Institutions can stabilize expectations about what others are likely to do, what conduct will be recognized, which procedures will be followed, how rules will be enforced, and whether commitments will persist. Such expectations can reduce some forms of uncertainty and make coordination possible across actors who do not share detailed personal knowledge. They can also become fragile when enforcement, classification, policy, organizational practice, or wider historical conditions change.

Institutional expectations are heterogeneous. Some concern descriptive anticipation: participants expect a payment system to operate or a licensing office to apply a known procedure. Others concern normative expectations about appropriate conduct. Still others concern anticipated reactions to rules, announcements, rankings, or classifications. These forms can interact but should not be collapsed into one generic expectation variable.

Expectations can also participate in feedback. Merton's account of self-fulfilling prophecy provides a classic mechanism in which a socially consequential definition helps generate behavior that contributes to producing the anticipated condition (Merton 1948). In institutional settings, expectations about creditworthiness, organizational stability, policy continuity, market participation, or rule enforcement can sometimes alter behavior in ways that stabilize or destabilize the expected configuration. Such feedback should be demonstrated rather than assumed.

12.12.8 Institutional Memory

Institutional memory concerns the ways past rules, decisions, classifications, cases, interpretations, records, routines, infrastructures, and learned expectations remain available to condition later action. Memory can reside in statutes, case records, archives, databases, procedural manuals, precedents, standards, professional training, organizational routines, material infrastructures, or tacit interpretive practices distributed across participants.

Institutional memory therefore differs from a complete historical record. Some events are recorded densely, others sparsely, and some forms of experience remain outside official documentation. Records can be lost, inaccessible, selectively retained, reclassified, or made legible only through later interpretive frameworks. Memory is consequently distributed and selective, and its practical accessibility can vary across positions.

The economic effect of memory can be substantial. Past classifications can condition future eligibility; precedents can influence interpretation; historical defaults can structure software and administrative routines; accumulated records can lower verification costs; and earlier exclusions can remain encoded in present infrastructures. Institutional memory can thus support continuity while also carrying historical path dependence into later decisions.

Remark 12.51 (Distributed institutional memory). Institutional memory can be distributed across documents, organizations, technologies, professional communities, and embodied practice. Locating the relevant memory therefore requires tracing the mechanisms through which past events remain accessible to later institutional action.

12.12.9 Institutional Reproduction

Institutional reproduction occurs when rules, norms, classifications, expectations, positions, and procedures remain practically available through recurrent enactment across events. Reproduction can involve compliance, enforcement, teaching, certification, documentation, imitation, interpretation, resource commitment, and the repeated recognition of statuses or boundaries. It can also involve incremental modification. Exact repetition is therefore only one possible form of institutional continuity.

Giddens's account of structuration emphasizes that rules and resources can be recursively implicated in the practices through which social structures are reproduced (Giddens 1984). GRE uses a compatible but more modest proposition: institutional infrastructure can persist because actors repeatedly draw upon it while acting, and their actions can simultaneously modify the conditions available for later action. The relevant empirical task is to identify which mechanisms carry continuity and which introduce change.

Reproduction is also uneven. Different actors can reproduce different parts of an institution, and institutional continuity at one scale can coexist with transformation at another. A classification can remain formally stable while its interpretation changes. A norm can persist within one profession while weakening elsewhere. A legal entitlement can remain codified while administrative access changes. Claims of institutional persistence should therefore specify the relevant dimension and scale.

Proposition 12.52 (Reproduction through situated enactment). *Institutional continuity can be generated through recurrent situated enactment rather than exact replication. Persistence in recognized positions, procedures, expectations, or classifications can co-exist with local variation in interpretation and practice.*

Proposition 12.52 gives institutional persistence an event-historical interpretation. The institution is reconstructed through sequences of enactment, recognition, interpretation, recording, enforcement, and contestation. This representation allows stability and gradual change to be analyzed within the same historical architecture.

12.12.10 Institutional Transformation

Institutional transformation concerns changes in the relational infrastructure through which economic interaction is organized. Transformation can occur through formal legal reform, altered administrative practice, new classification systems, shifts in norms, changes in expectations, technological mediation, organizational reconfiguration, reinterpretation, changed enforcement, crisis, collective action, or combinations of these processes. The relevant transformation may be abrupt or gradual and may operate unevenly across scales.

Formal change is therefore one possible indicator of institutional transformation rather than a complete measure of it. A statutory amendment can have limited practical effect if administrative routines, classifications, resources, and expectations remain unchanged. Conversely, institutional practice can change substantially before formal rules are rewritten. The distinction between formal rule and enacted relational structure is especially important when evaluating reform.

Transformation can also alter the conditions under which later institutional change occurs. New rights can create new claimants and organizations; new classifications can reorganize data and eligibility; new technologies can redistribute

monitoring capacity; new administrative routines can alter information flows; and changed expectations can affect compliance or contestation. Institutional change can therefore be generative in the descriptive sense developed throughout GRE: it can modify later capacities, relations, boundaries, and possible histories.

Remark 12.53 (Institutional transformation and normative evaluation). The capacity of an institutional transformation to generate new relations or possibilities does not establish that the transformation is desirable. Evaluation requires separate attention to the affected positions, values, capacities, risks, exclusions, responsibilities, and historical conditions relevant to the inquiry.

Institutions, on this account, are neither static containers around economic action nor interchangeable with the organizations that enact them. They are historically reproduced relational infrastructures whose rules, norms, legal positions, administrative practices, classifications, expectations, and memories condition recurring economic relations while remaining open to contestation and revision. This perspective prepares analysis of more specific institutional configurations—including markets—without presuming that any one institutional form exhausts the economic domain.

12.13 Markets as Relational Fields

Markets are economically consequential because they can coordinate heterogeneous participants, exchanges, prices, information, expectations, competitive pressures, cooperative practices, and intermediating institutions across relations that extend beyond any single transaction. This section develops markets as *relational fields*: historically constituted configurations in which participation conditions, exchange relations, price formation, information, expectations, competition, cooperation, intermediation, and boundary practices jointly condition what transactions are possible and how their consequences propagate. Its objective is to preserve the analytical importance of price-mediated exchange while situating that process within the wider relational architecture that makes market participation, comparison, enforcement, interpretation, and adaptation possible. The discussion is economic, institutional, and historical. It treats a market field as a revisable analytical representation rather than a self-evident natural boundary, and it leaves open which mechanisms are dominant in a particular case.

Several established traditions motivate this broader treatment. Walrasian analysis demonstrates the analytical power of representing interdependent prices and quantities within systems of exchange (Walras 1874). Hayek emphasizes the coordination problem created by knowledge that is dispersed, incomplete, and unevenly held across participants, and the role that price changes can play in communicating selected information through decentralized adjustment (Hayek 1945). Granovetter shows that economic action remains embedded in ongoing social relations rather than occurring among fully atomized actors (Granovetter 1985). Polanyi's historical analysis further emphasizes that market organization is instituted within broader social and political arrangements and can itself transform those arrangements (Polanyi 1944; Polanyi 1957). GRE treats these contributions as analytically complementary rather than mutually exclusive: prices, institutions, social relations, expectations, and organizational forms can each become causally important under different market conditions.

Definition 12.54 (Market relational field). For a specified class of economically relevant exchanges, participants, objects, and time horizon, a *market relational field* is a comparatively stabilized yet revisable configuration of participation conditions, exchange relations, price relations, information pathways, expectations, competitive and cooperative relations, intermediaries, institutional supports, and boundaries through which exchange possibilities are formed, compared, enacted, and transformed. The relevant field can be local, sectoral, platform-mediated, national, transnational, or otherwise delimited according to the mechanism under study.

Definition 12.54 does not require that every market contain the same institutional arrangements or that every economically relevant exchange occur through a market. The definition identifies a family of configurations in which exchange and comparison are recurrently organized. It is compatible with highly decentralized exchange, organized exchanges, auction systems, platform markets, regulated markets, informal markets, and other arrangements, provided that the empirical mechanisms supporting participation and exchange are specified.

The field language also requires restraint. A market field is not presumed to possess a literal physical field ontology. The term is useful when participants and transactions are conditioned by a wider configuration of prices, expectations, rules, infrastructures, networks, classifications, and intermediaries whose effects cannot be adequately represented as a single isolated dyad. Where such wider conditioning is weak, a simpler transactional representation can be preferable.

Table 12.15 summarizes the principal dimensions developed in this section. The dimensions can overlap and need not be equally salient in every market configuration.

12.13.1 Participation

Market participation concerns more than the formal permission to buy or sell. It can depend on legal status, identity verification, access to money or credit, information, infrastructure, language, technical compatibility, geographic reach, reputation, organizational membership, regulatory eligibility, and the practical ability to bear risk or wait for settlement. Participation is therefore a relational capacity constituted through several of the boundary and access dimensions developed earlier in this chapter.

The set of participants can also be stratified by role. Buyers, sellers, brokers, market makers, platforms, exchanges, lenders, insurers, rating bodies, regulators, data providers, payment processors, and other actors can occupy different positions within the same field. Their capacities to observe, initiate, delay, refuse, price, rank, or settle transactions can differ substantially. A market analysis that records only final buyers and sellers can therefore omit relations that materially condition exchange.

Formal openness and effective participation should consequently be distinguished. A market can be legally open while practical participation remains concentrated because transaction size, technical requirements, information costs, accreditation, geography, capital requirements, or network access create substantial entry conditions. Conversely, informal participation can arise outside formally recognized channels. The relevant empirical question concerns which conditions actually organize participation for the process under study.

Table 12.15: Selected dimensions of markets as relational fields.

Dimension	Relational object	Illustrative analytical questions
Participation	Conditions governing practical entry, recognition, access, eligibility, and capacity to transact	Who can participate, under which conditions, with what resources, rights, information, and practical alternatives?
Exchange	Reciprocal, contractual, or otherwise organized transfer relations	What is exchanged, under which obligations, and through which institutional and relational supports?
Prices	Monetary or other quantified terms that condition comparison and exchange	How are prices formed, interpreted, transmitted, constrained, and incorporated into later action?
Information	Unevenly distributed signals, records, knowledge, classifications, and disclosures	Which information becomes available to whom, through which channels, and with what delay or asymmetry?
Expectations	Anticipations concerning prices, conduct, availability, policy, quality, and others' responses	How do expectations coordinate or destabilize participation and exchange?
Competition	Relations through which participants contest opportunities, customers, inputs, positions, or standards	Which dimensions of competition matter, and which institutional conditions structure them?
Cooperation	Joint practices that support standards, infrastructures, information, interoperability, or collective provision	Which cooperative relations make exchange possible or reshape competitive conditions?
Intermediation	Positions that connect, filter, certify, match, clear, finance, rank, or otherwise mediate exchange	Which intermediaries alter access, information, bargaining conditions, or transaction pathways?
Boundaries	Practical and analytical distinctions defining which participants, objects, transactions, and substitutes belong to the field	Who defines the market boundary, for which purpose, and how does the boundary affect analysis or governance?
Formation and transformation	Historical processes that create, stabilize, expand, segment, integrate, or reorganize market relations	Which institutional, technological, organizational, and behavioral changes reshape the field over time?

Remark 12.55 (Participation as a differentiated capacity). Market participation can be represented as a bundle of differentiated capacities—including entry, observation, comparison, negotiation, transaction, settlement, exit, and redress—rather than as a single binary membership variable. Which capacities matter depends on the market

mechanism being analyzed.

12.13.2 Exchange Relations

Exchange relations organize transfers of goods, services, claims, access, labor, information, rights, or other economically recognized objects under specified terms. Their market form depends on more than the physical movement of an object. The exchange can require recognized ownership or authority to transfer, contractual interpretation, quality assessment, payment infrastructure, settlement, enforcement, and expectations concerning counterpart performance.

The same observable transfer can also participate in several relation-forms at once. A labor contract can contain exchange, authority, knowledge, dependency, trust, and legal relations. A credit transaction can combine transfer, future obligation, collateral relations, information asymmetry, and institutional enforcement. Market exchange should therefore be treated as one relational dimension within a thicker configuration rather than as evidence that other relation-forms have disappeared.

Coase's analysis of the firm remains useful because it makes the institutional organization of exchange itself economically relevant: using market exchange can involve search, contracting, negotiation, monitoring, and other costs, while organization can substitute different coordination mechanisms for some transactions (Coase 1937). GRE extends the analytical implication without presuming a universal market–hierarchy dichotomy. Network coordination, common arrangements, platforms, professional institutions, and hybrid forms can combine market exchange with other mechanisms (Powell 1990; Ostrom 2010).

12.13.3 Price Relations

Prices are among the most visible relational objects in market analysis because they summarize terms under which exchange can occur and can transmit information relevant to decentralized adjustment. Their analytical importance is substantial. Price changes can alter production plans, consumption choices, entry, substitution, investment, inventory, expectations, and the relative attractiveness of alternative transactions. Hayek's account emphasizes that such adjustment can make use of dispersed knowledge without requiring that a central actor possess all underlying information (Hayek 1945).

A relational account nevertheless separates the observed price from the complete structure producing and responding to it. A quoted price can depend on auction rules, bargaining power, market-making practices, inventory, credit conditions, regulation, platform design, expectations, quality classification, information asymmetry, and the available set of alternatives. Similar prices can therefore arise under different relational configurations, and identical price changes can carry different meanings for differently positioned participants.

Prices can also become performative when they enter later decisions and thereby affect the conditions from which future prices are generated. The effect can be direct, as when a price threshold triggers a contract or margin call, or indirect, as when price histories alter expectations, rankings, investment, or regulatory attention. The existence and magnitude of such feedback are empirical matters. MacKenzie's analysis of financial models provides a prominent case in which representations and models can

become incorporated into market practices and contribute to reshaping the markets they describe (MacKenzie 2006).

Proposition 12.56 (Price–configuration non-equivalence). *Observed price relations do not uniquely identify the relational configuration that generated them. Market analysis can therefore require evidence about institutions, participation, information, bargaining, intermediation, and expectations when these mechanisms materially affect price formation or response.*

Proposition 12.56 is an epistemic caution rather than a rejection of price analysis. In settings where price mechanisms dominate and the relevant institutional conditions are stable, price-centered models can be highly informative. The proposition becomes important when different underlying configurations produce similar observables or when institutional and relational change alters the interpretation of price movements.

12.13.4 Information Relations

Markets are also organized through information relations. Participants differ in what they know about quality, availability, costs, counterparties, future conditions, rules, technologies, and alternatives. Information can arrive through prices, contracts, ratings, disclosures, advertising, reputation, professional networks, public statistics, platform interfaces, direct experience, and informal communication. The resulting information structure is therefore distributed across heterogeneous channels rather than reducible to a single common information set.

Information itself has distinctive economic properties. Arrow’s analysis of invention emphasizes uncertainty and appropriation problems that make information and knowledge difficult to treat as ordinary commodities (Arrow 1962). More generally, the capacity to produce, verify, conceal, certify, rank, or interpret information can become economically consequential even when the information is nominally available to everyone. Information access and epistemic capacity should therefore be distinguished.

Market information can also be selectively legible. Standardized classifications, accounting categories, ratings, benchmarks, prices, and platform metrics make some properties easy to compare while leaving others difficult to observe. This can facilitate exchange while compressing heterogeneity. The effect is especially important where participants adapt behavior to the representation used for evaluation or ranking. In such cases, the information relation and the market relation can co-evolve.

12.13.5 Expectations

Expectations connect present market relations to anticipated future events. Participants can form expectations about future prices, demand, supply, policy, interest rates, technology, quality, counterpart behavior, market access, or the responses of other participants. These expectations can influence present orders, investment, inventories, hiring, credit, entry, exit, and contractual design.

Expectations can arise through heterogeneous processes. Some are produced through formal models or forecasts; others through experience, routines, professional narratives, imitation, public announcements, market indicators, or network communication. The same observable forecast can also have different consequences

depending on who receives it, what authority is attributed to it, and which actions become available in response.

Expectations can generate feedback when anticipatory action alters the future conditions being anticipated. Such feedback need not be stabilizing. Expectations can support coordination when participants converge on compatible assumptions, but they can also amplify volatility, crowding, or abrupt revaluation when many actors respond similarly to the same representation. GRE therefore treats expectations as relationally situated epistemic conditions whose practical effects depend on institutional and market structure.

12.13.6 Competition

Competition concerns relations through which participants contest customers, inputs, contracts, attention, positions, standards, financing, labor, intellectual resources, or other opportunities. Its form depends on what can be contested, who can enter, which substitutes exist, how information is distributed, what switching costs apply, and which institutional rules structure conduct. Competition is therefore a relational pattern rather than a self-explanatory property of a market label.

Competitive relations can operate through price, quality, innovation, speed, reputation, interoperability, access, location, service, data, standards, or other dimensions. The relevant dimensions can change historically. Network effects can make installed participation itself economically important, so that the value of a product or system depends partly on how many others use compatible systems (Katz and Shapiro 1994). Under such conditions, competition can concern the architecture of compatibility and installed networks as much as the price of an isolated product.

Competition also interacts with organizational and institutional structure. Rules concerning entry, ownership, intellectual property, procurement, interoperability, disclosure, labor mobility, and finance can alter competitive possibilities. An account of competition should therefore specify the relevant field and mechanism rather than infer competition solely from the presence of multiple sellers or buyers.

12.13.7 Cooperation

Market fields can contain cooperation alongside competition. Participants may jointly establish standards, payment systems, clearing arrangements, shared infrastructures, professional practices, certification systems, interoperability protocols, research collaborations, or collective governance arrangements. Cooperation can reduce coordination costs, enlarge the field, improve compatibility, or stabilize expectations while leaving substantial competition in other dimensions.

This coexistence is visible in network forms of organization, where reciprocal communication and repeated relationships can organize economic activity beyond both spot exchange and unified hierarchy (Powell 1990). Polycentric arrangements similarly show that multiple centers of decision can combine autonomy, coordination, and shared rules in complex economic systems (Ostrom 2010). These examples support a broader analytical point: competitive and cooperative relations can be jointly constitutive of the same market field.

Cooperation has no automatic normative status. Shared standards can enable participation while also raising entry costs; joint infrastructures can distribute capacity

widely or concentrate control; information sharing can improve coordination or facilitate exclusion. GRE therefore separates the presence of cooperation from judgments concerning its distributional, political, or ethical consequences.

Remark 12.57 (Competitive–cooperative composition). A market field can contain simultaneous competition and cooperation across different relational dimensions. Analysis should identify the object and mechanism of each relation rather than assign the field a single competitive or cooperative character.

12.13.8 Intermediation

Intermediaries occupy positions between participants, transactions, information sources, or institutional systems. Brokers, dealers, exchanges, banks, platforms, clearing organizations, rating agencies, certifiers, wholesalers, matching services, payment processors, and other actors can reduce some search or coordination burdens while introducing new dependencies, fees, filters, classifications, and control points.

Intermediation can affect who encounters whom, which offers become visible, how quality is certified, how risk is allocated, how payment is settled, which information is collected, and how disputes are resolved. An intermediary can therefore become economically consequential without acquiring ownership of the exchanged object. Its position can generate capacities through connectivity and coordination while also creating bottlenecks or asymmetric dependence.

Digital platforms make this especially visible because participation, ranking, payment, reputation, matching, access rules, data collection, and technical standards can be concentrated within one mediating infrastructure. Chapter 12 treats platforms and infrastructures separately because those configurations can extend beyond market intermediation. Within the present section, the narrower point is that intermediation can become part of the market field's architecture and should be represented when it materially conditions exchange.

12.13.9 Market Boundaries

A market boundary specifies which participants, products, services, locations, time horizons, technologies, substitutes, and institutional conditions are treated as belonging to the same market for a particular inquiry. Such boundaries can be practically consequential and analytically contested. A competition authority, a firm, a platform operator, a trader, and a researcher can draw different boundaries because they are answering different questions.

Market boundaries can be organized through geography, substitutability, regulation, language, technical compatibility, logistics, licensing, payment systems, network membership, customer practice, or other mechanisms. They can also be porous. Imports can connect previously separated price systems; digital platforms can create cross-border exchange; standards can integrate some participants while excluding incompatible systems; and regulation can segment markets that would otherwise share suppliers or consumers.

Rodrik's analysis of international economic integration illustrates how market integration interacts with jurisdictional and political boundaries rather than simply dissolving them (Rodrik 2000). More generally, the practical field can cross formal ju-

jurisdictional boundaries while remaining dependent on institutions that differ across those jurisdictions. Market-boundary analysis should therefore specify the mechanism of integration or segmentation rather than equate the relevant market with an administrative territory.

Proposition 12.58 (Market-boundary relativity). *The economically relevant boundary of a market field is relative to the object of exchange, substitution possibilities, institutional conditions, spatial and temporal scale, and the mechanism under investigation. Different defensible boundaries can therefore coexist for different analytical purposes.*

12.13.10 Market Formation and Transformation

Markets form historically when sufficiently recurrent relations of participation, comparison, exchange, payment, information, recognition, and enforcement become available around an economically relevant class of objects or activities. Formation can involve legal change, technological innovation, organizational entrepreneurship, standardization, new infrastructures, new classifications, changing property relations, changes in mobility, or shifts in social practice. There is consequently no requirement that a market pre-exist the institutional and technological processes through which it becomes practically possible.

Transformation can modify any dimension of the field. New intermediaries can reorganize matching and visibility; new regulation can change entry, disclosure, or liability; technical standards can integrate or fragment participants; network effects can alter competitive dynamics; new information systems can change observability; financial innovation can change the objects being exchanged; and changes in expectations can reshape participation before formal institutions change. Market transformation can therefore be gradual, abrupt, local, or multiscale.

Polanyi's historical analysis is especially relevant here because it treats market organization as historically instituted and capable of reorganizing wider social relations (Polanyi 1944; Polanyi 1957). GRE adopts the historical lesson without assuming a single trajectory of market development. Market formation and transformation can take heterogeneous paths, and different market forms can coexist with organizations, commons, households, public institutions, networks, and other modes of economic coordination.

Market fields can also transform through their own representations. Price indices, ratings, classifications, forecasts, risk models, benchmarks, and platform metrics can become incorporated into participant behavior and institutional practice. Where such feedback is strong, the market representation becomes part of the relational field whose future behavior it helps condition. This possibility connects market analysis to the book's broader treatment of performative epistemic events while remaining an empirical hypothesis for each case.

Remark 12.59 (Markets as historically revisable analytical objects). A market field should be treated as a revisable analytical object. Changes in participation, substitutes, institutions, intermediation, technology, information, expectations, or scale can justify changing the field boundary or replacing a market-centered representation with another economic configuration better suited to the inquiry.

Markets, on this account, are relationally organized exchange fields whose prices, participants, information, expectations, competitive and cooperative relations, intermediaries, and boundaries can acquire substantial coordinating effects while remain-

ing historically constituted and institutionally supported. This representation preserves the analytical power of market and price analysis while keeping visible the relations through which markets become possible, differentiated, and transformable. It also leaves conceptual space for economic forms in which exchange is embedded within household, community, common, platform, infrastructural, or other relational arrangements.

12.14 Households, Communities, and Commons

Households, communities, and commons provide economically consequential forms of coordination whose internal logic cannot be inferred from market exchange, organizational hierarchy, or state administration alone. This section develops them as heterogeneous relational configurations through which care, provision, dependency, allocation, shared resources, rules, reciprocity, stewardship, and collective capacities can be organized. The objective is analytical rather than classificatory: GRE does not treat households, communities, or commons as a single “non-market” domain, and it does not presume that these forms are intrinsically cooperative, equitable, sustainable, or normatively preferable. The discussion instead identifies recurrent relational dimensions that can help reconstruct how such configurations operate under particular historical and institutional conditions. Table 12.16 summarizes the principal dimensions used in the section.

The three categories named in the section title overlap without being equivalent. A household can participate in several communities and depend on common resources; a community can contain many households without constituting a household; and a commons can be governed by a community whose membership, resource users, and legal owners only partially overlap. The relevant analytical boundary therefore depends on the mechanism under investigation. GRE treats these categories as revisable relational descriptions rather than as fixed natural units.

Definition 12.60 (Household, community, and commons configurations). Within the present framework, a *household configuration* is a historically situated arrangement through which some participants organize recurrent provision, care, residence, resource use, obligation, or support; a *community configuration* is an arrangement in which participants are connected through sufficiently recurrent membership, shared practice, identification, locality, institution, or mutual obligation for the relevant inquiry; and a *commons configuration* is an arrangement in which access to, use of, maintenance of, or claims over a shared resource are governed through relations among multiple participants. These descriptions are analytical and may overlap in a single empirical setting.

12.14.1 Household Membership

Household membership can be defined through co-residence, kinship, marriage or partnership, legal registration, pooled resources, caregiving, shared consumption, shared debt, mutual obligation, or other relations. These criteria need not identify the same set of persons. Someone can contribute resources without residing in the household, receive care while living elsewhere, retain formal membership after practical separation, or share a dwelling without participating in a common provision

Table 12.16: Selected relational dimensions of households, communities, and commons

Dimension	Analytical object	Questions for relational analysis
Household membership	Co-residence, kinship, legal status, contribution, dependence, recognition	Who is treated as a member for which purposes, and how do effective participation and formal status differ?
Care relations	Attention, maintenance, bodily and emotional support, social reproduction	Who gives and receives care, under what expectations, and with what effects on capacity, time, and dependency?
Provision	Acquisition and organization of resources needed for recurrent life and activity	Which resources are provided, through which relations, and how are market, public, household, and community channels combined?
Dependency and support	Unequal need, capacity, access, and reliance	Which dependencies are temporary, structural, reciprocal, asymmetric, enabling, or constraining?
Internal allocation	Distribution of money, time, goods, space, labor, attention, and opportunities	Which rules, negotiations, claims, or power relations shape access within the configuration?
Shared resources	Resources used, maintained, or governed by multiple participants	What are the relevant resource characteristics, access rules, exclusion mechanisms, and appropriation conditions?
Community governance	Rules, norms, monitoring, sanctioning, representation, and dispute resolution	How are collective expectations produced, enacted, challenged, and revised?
Reciprocity	Repeated giving, support, recognition, or return across time	What counts as return, over which horizon, and how are asymmetry, memory, and expectation organized?
Stewardship	Maintenance, repair, preservation, regeneration, or transformation of shared resources	Who bears responsibility for maintenance, who can alter the resource, and whose future claims are represented?
Collective capacity	Capabilities generated through coordination, shared resources, knowledge, or mutual support	Which capacities exist because of the configuration, who can access them, and how are their benefits and burdens distributed?

structure. Household analysis therefore benefits from specifying the membership dimension relevant to the question rather than assuming a single household boundary.

This distinction is economically consequential because membership can affect claims on income, housing, time, care, inheritance, insurance, public benefits, taxation, credit, and decision authority. It can also shape exposure to the consequences of other members' decisions. A household centered only on co-residence may understate remittance relations, intergenerational support, translocal care, or obligations extending beyond the dwelling. Conversely, kinship alone may overstate practical

coordination where finances, care, and daily provision are largely separate.

Feminist economic analysis has emphasized that household and family decisions are situated within broader structures of gender, age, class, and other constraints, including the distribution of unpaid work and the costs of social reproduction (Folbre 1994). GRE adopts the analytical implication without presuming a universal household form: the internal distribution of capacity, obligation, voice, and dependency should be reconstructed for the configuration under study.

Remark 12.61 (Household boundaries as dimension-relative). Household membership for residence, care, income pooling, legal responsibility, inheritance, or emotional attachment can yield different boundaries. A household analysis should state which boundary is being used and why it is adequate to the mechanism under investigation.

12.14.2 Care Relations

Care relations concern activities and commitments through which persons or other living beings are maintained, supported, attended to, or enabled to continue functioning and developing. Care can include bodily assistance, supervision, emotional support, childrearing, eldercare, disability support, household maintenance, health-related assistance, and forms of attention that sustain everyday participation. Such relations can occur within households, paid employment, public services, communities, voluntary organizations, or mixed arrangements.

Care has economic significance because it can generate and preserve capabilities while consuming time, attention, material resources, and opportunities. It can also redistribute these burdens unevenly. England's review of care-work theory shows that care can be organized both inside households and through paid markets, with its valuation shaped by several competing mechanisms and interpretations (England 2005). Folbre similarly emphasizes the economic importance of caregiving responsibilities and the institutional distribution of those responsibilities (Folbre 2001).

GRE treats care neither as an intrinsically harmonious relation nor as reducible to a market service. A care relation can be supportive, reciprocal, professional, familial, obligatory, exploitative, or some combination depending on the configuration. The relevant analysis can distinguish the recipient's needs, the caregiver's capacities and constraints, the temporal intensity of care, possibilities for substitution or respite, recognition and compensation, and the institutional arrangements that condition the relation.

Care also illustrates why economic consequences cannot always be inferred from monetary flows. Unpaid care can materially affect labor-market participation, health, learning, household resilience, and future capabilities even when no price is recorded. Paid care, conversely, can remain embedded in trust, emotional expectations, professional norms, and asymmetries that are not exhausted by the wage relation.

12.14.3 Household Provision

Provision concerns the recurrent acquisition, production, organization, and maintenance of resources needed for household life and participation. Food, shelter, energy, clothing, transportation, health care, education, communication, care, security, and

discretionary resources may be provided through wages, self-production, public services, transfers, gifts, shared assets, credit, community support, or combinations of these channels.

A provision-centered view is useful because household command over resources is not identical to aggregate availability. Sen's entitlement analysis demonstrates the importance of examining the legally and institutionally mediated means through which people can command food and other resources, rather than inferring access directly from total supply (Sen 1981). In a broader capability-oriented formulation, effective opportunity depends on the interaction of resources with personal, social, and institutional conditions (Sen 1999).

Within GRE, provision is therefore represented as a relational process linking external income and entitlement structures to internal allocation, care, household production, and dependency. A household with similar monetary income to another may have different provision capacities because of health needs, housing conditions, debt, care burdens, public-service access, household size, geography, or unequal control over pooled resources. Provision analysis should consequently avoid treating household income as a complete representation of internal economic capability.

12.14.4 Dependency and Support Relations

Dependency refers to conditions in which a participant's access to resources, care, mobility, protection, recognition, or opportunities depends materially on another participant or configuration. Dependency can arise from childhood, illness, disability, age, temporary hardship, specialized knowledge, legal status, financial obligation, infrastructure, or the organization of work and care. It can also be produced by prior decisions that narrow alternatives.

Dependency has several possible relational forms. Some dependencies are expected and temporary; others are long-term. Some are reciprocal across different domains or time horizons, while others are strongly asymmetric. A person may depend on another for care while providing income, knowledge, emotional support, or future obligations in return. Apparent independence in one dimension can coexist with strong dependency in another.

The economic significance of dependency lies partly in how it redistributes bargaining position, time, exposure, and exit capacity. Formal equality among household members or community participants can coexist with practical differences in access to income, documentation, housing, transport, social networks, or care alternatives. GRE therefore treats dependency as a relational condition to be specified empirically rather than as a fixed personal attribute.

Support relations are analytically broader than dependency. Participants can provide resources, information, care, advocacy, guarantees, access, or emergency assistance without creating a persistent dependency relation. The distinction matters because the same support can expand another participant's future capabilities or, under different conditions, make continued participation increasingly contingent on a particular provider.

12.14.5 Internal Resource Allocation

Internal allocation concerns the distribution of money, goods, time, space, labor, care, attention, risk, and opportunities among participants within a household or community configuration. Allocation can occur through explicit rules, negotiation, custom, role expectations, seniority, need, contribution, bargaining power, emergency, or tacit routines. Several logics can operate simultaneously.

Household-level aggregates can obscure this internal distribution. Equal household income per capita, for example, does not establish equal control over expenditures, equal consumption, equal leisure, equal access to education, or equal exposure to unpaid work. For GRE, the appropriate unit of analysis therefore depends on the question: the household can be a useful entity for some mechanisms while requiring decomposition into internal positions for others.

Internal allocation can also be dynamic. Current allocation influences future capabilities through nutrition, education, health, rest, savings, debt, skill formation, and social participation. An allocation that appears small in a short-period budget can have larger historical consequences if it changes later options or dependencies. This generative effect is analytically distinct from a normative judgment about whether the allocation is fair.

Proposition 12.62 (Household-aggregate non-equivalence). *For questions concerning individual access, burden, capability, or decision authority, household-level resource aggregates are generally insufficient unless the relevant internal allocation mechanism is shown to make the aggregate an adequate proxy for the positions being analyzed.*

12.14.6 Shared Resources and Common-Pool Arrangements

Shared resources are resources whose use, maintenance, access, or value involves multiple participants. They can include land, water, fisheries, forests, irrigation systems, shared housing facilities, knowledge repositories, digital infrastructure, community funds, equipment, or other resources whose economically relevant characteristics depend on collective use or governance. Different shared resources create different problems of exclusion, congestion, depletion, maintenance, and contribution.

Commons analysis requires an especially important distinction between a *resource* and the *institutional arrangement* governing it. The influential tragedy-of-the-commons model describes one possible dynamic of unregulated appropriation from a shared resource (Hardin 1968). Subsequent empirical institutional research has documented a wider range of self-organized common-pool-resource arrangements, including durable governance systems as well as failures (Ostrom 1990). GRE therefore avoids treating “commons” as synonymous with open access or with a single governance form.

A commons configuration can involve rules concerning eligibility, appropriation, contribution, monitoring, sanctions, dispute resolution, maintenance, modification, and succession. These arrangements may be formal or informal and can interact with state law, markets, organizations, households, and technologies. The economically relevant object is consequently the resource together with the relational architecture through which participants access, use, reproduce, or transform it.

Commons can also extend beyond natural resources. Knowledge commons, for

example, raise questions of access, enclosure, preservation, intellectual property, contribution, and governance while differing materially from subtractable natural-resource systems (Hess and Ostrom 2007). Similar vocabulary should therefore be transferred across resource types only after the relevant mechanisms have been specified.

Caution 12.63 (Commons and open access). A shared resource should not be described as a commons merely because multiple people can access it. Commons analysis requires attention to the relations and rules through which access, use, contribution, maintenance, and conflict are organized. Open access is one possible configuration among others.

12.14.7 Community Rules and Governance

Community governance concerns the recurrent rules, norms, roles, expectations, monitoring practices, representations, and dispute-resolution arrangements through which participants coordinate shared activities or resources. A community need not possess a unified constitution or formal government. Governance can be distributed across customary practices, associations, committees, elders, technical systems, local organizations, public agencies, or overlapping institutional arrangements.

Ostrom's institutional work emphasizes that rules used by participants, community attributes, and action situations jointly shape patterns of interaction and outcomes (Ostrom 2005). This supports a relational treatment in which community rules acquire significance through enactment rather than through textual existence alone. A nominal rule can remain weak if participants lack information, legitimacy, monitoring capacity, or feasible enforcement; an informal rule can be highly consequential when it structures expectations and recurrent behavior.

Community rules can govern access, contribution, timing, maintenance, representation, sanctioning, information sharing, membership, conflict resolution, and the amendment of the rules themselves. They can also distribute authority unevenly. Analysis should therefore examine who can participate in rule formation, who can interpret or enforce rules, who bears their costs, and which members or affected outsiders possess avenues for contestation.

The presence of community governance carries no automatic normative conclusion. Local rules can sustain shared capacities and mutual support, but they can also reproduce exclusion, hierarchy, or burdens that are difficult for some participants to challenge. GRE treats governance performance and normative evaluation as separate questions requiring explicit criteria.

12.14.8 Reciprocity Relations

Reciprocity concerns relations in which present acts are connected to remembered, expected, or normatively salient acts of return across time. Return need not take the same form as the original contribution. Material assistance can be answered by care, information, labor, protection, future help, recognition, or participation in collective tasks. Reciprocity can therefore operate through heterogeneous value forms and long time horizons.

Ostrom's behavioral analysis of collective action identifies reciprocity, reputation, and trust as important mechanisms through which participants can sustain coopera-

tion in repeated social dilemmas (Ostrom 1998). GRE treats these mechanisms as empirically contingent relational processes rather than as universal motivations. Their operation can depend on observability, memory, group structure, exit possibilities, power, institutional rules, and shared interpretations of what counts as an adequate return.

Reciprocity should also be distinguished from exact equivalence. Participants may accept asymmetric contributions because needs, capacities, timing, or roles differ. Conversely, an apparently reciprocal relation can conceal coercive expectations where participants cannot realistically refuse, exit, or renegotiate obligations. A relational analysis therefore examines how obligations are remembered and interpreted, who defines adequate return, and how differences in power affect the meaning of reciprocity.

12.14.9 Resource Stewardship

Stewardship concerns activities through which participants maintain, repair, preserve, regenerate, monitor, or deliberately transform resources whose future condition matters to the configuration. The concept can apply to land, water, buildings, infrastructures, knowledge, archives, community funds, ecosystems, technical systems, or other shared resources. It directs attention to temporal relations between present use and future capacity.

Stewardship should remain analytically separate from preservation. Maintaining a resource can require change: repair, ecological restoration, technological replacement, institutional redesign, or changes in access rules. In other cases, continued preservation of an inherited arrangement may impose costs on current participants or protect a configuration that has lost its practical justification. The relevant inquiry is therefore which resource qualities or capacities are being maintained, for whom, over which horizon, and through which obligations and authorities.

Research on social–ecological systems illustrates the value of analyzing resource systems, resource units, governance systems, users, interactions, and outcomes together rather than isolating one dimension (Ostrom 2009). GRE draws on this systems lesson while retaining scope discipline: stewardship of a shared economic resource should be specified through the concrete mechanisms of access, maintenance, regeneration, monitoring, and transformation relevant to the case.

Stewardship can also distribute burdens unevenly across time. Current participants may bear maintenance costs that benefit future participants, while future costs can be generated by present extraction or underinvestment. Such temporal distribution raises normative questions, but GRE does not infer one universal stewardship principle. The first task is to make the intertemporal relational structure visible enough for evaluation under the relevant commitments.

12.14.10 Collective Capacity

Household, community, and commons configurations can generate capacities that are unavailable, more costly, or less reliable when participants act separately. Shared childcare, pooled savings, collective purchasing, mutual insurance, common infrastructure, shared knowledge, coordinated maintenance, emergency support, and joint governance can expand what participants are able to do. Such capacities can arise

through complementarity, specialization, trust, repeated interaction, resource pooling, or institutionalized cooperation.

Collective capacity should be distinguished from equal access to that capacity. A community may possess a shared facility while some members face practical barriers to using it; a household may hold assets that one member cannot control; a commons may support productive activity while benefits are unevenly distributed. The existence of a collective capacity therefore establishes neither equal participation nor normative desirability.

The same configuration can also generate vulnerability. Resource pooling can increase resilience to some shocks while creating exposure to common failure; dense mutual support can reduce individual risk while making exit costly; strong community governance can coordinate maintenance while concentrating interpretive authority. GRE therefore treats collective capacity as one relational property among others, to be analyzed together with access, control, dependency, distribution, and revision.

Proposition 12.64 (Configuration-dependent collective capacity). *A collective capacity can be attributed to a household, community, or commons configuration when an identifiable relational mechanism makes the relevant capability depend materially on coordination, shared resources, complementary roles, common knowledge, or recurrent support within that configuration. Attribution of the capacity does not determine how access, control, burdens, or benefits are distributed among participants.*

Households, communities, and commons thus broaden the relational architecture of economic systems beyond exchange-centered representations without constituting a unified alternative to markets or organizations. Their economic significance can arise through membership, care, provision, dependency, allocation, shared resources, governance, reciprocity, stewardship, and collective capacity in combinations that vary across history and context. Treating these configurations as internally heterogeneous and externally connected prepares later analysis of platforms, infrastructures, resources, access, ownership, labor, coordination, asymmetry, and generative potential without assigning one institutional form a privileged normative status.

12.15 Platforms and Infrastructures

Platforms and infrastructures organize economic relations by shaping the conditions under which participants can connect, transact, coordinate, observe, interoperate, and build further activities. This section develops platforms and infrastructures as related but non-equivalent components of economic architecture. Its objective is to identify the relational mechanisms through which mediation, access, standards, interoperability, dependency, gatekeeping, network effects, and infrastructural change can condition later economic possibilities. The discussion remains architectural rather than sector-specific: digital platforms are important examples, but the framework also applies to non-digital exchanges, payment and logistics systems, communication networks, standards regimes, shared facilities, public infrastructures, and other arrangements where recurrent economic activity depends on common interfaces or enabling resources. Table 12.17 summarizes the dimensions used in the section.

Economic analysis of platforms has emphasized configurations in which participa-

tion on one side affects participation or value on another, making the organization of access and price structure important to the viability of the mediating system (Rochet and Tirole 2003). Research on systems competition likewise shows that compatibility and network effects can make adoption interdependent across users and technologies (Katz and Shapiro 1994). Infrastructure analysis adds a different emphasis: shared resources can serve as inputs into heterogeneous downstream activities, so access and governance conditions can influence a wide range of later productive and social uses (Frischmann 2012). GRE uses these literatures as complementary sources for relational reconstruction. A platform can mediate interactions without becoming infrastructure for every participant, and an infrastructure can enable many activities without organizing them through a platform-like relation.

Definition 12.65 (Platform-mediated architecture and infrastructural condition). For a specified economic inquiry, a *platform-mediated architecture* is a configuration in which a mediating entity, protocol, organization, or technical-institutional arrangement recurrently conditions interactions among two or more participant positions through access rules, interfaces, matching, ordering, standards, records, or governance. An *infrastructural condition* is a comparatively persistent material, technical, institutional, informational, or organizational arrangement on which heterogeneous downstream activities recurrently depend. Either form can overlap with the other, and neither description implies a fixed ontological category.

Definition 12.65 is deliberately functional and historical. The same empirical arrangement can be platform-like for one process and infrastructural for another. A payment network can mediate transactions among participants while simultaneously functioning as a shared infrastructural input to businesses that build additional services upon it. Conversely, a road, legal registry, technical standard, or communications backbone can condition economic action without performing the matching, ranking, or multi-sided coordination usually associated with platform mediation.

Proposition 12.66 (Platform–infrastructure non-equivalence). *Platform mediation and infrastructural conditioning identify different relational roles. Their empirical overlap should be established through the mechanisms of mediation, dependence, shared use, access, and governance relevant to the inquiry rather than inferred from a label such as “platform,” “network,” or “infrastructure.”*

12.15.1 Platform-Mediated Relations

Platform-mediated relations arise when an intermediary configuration recurrently conditions how distinct participant positions encounter, evaluate, transact with, or otherwise act in relation to one another. The mediating mechanism can include search, matching, ordering, ranking, identity verification, payment, settlement, reputation, scheduling, data exchange, technical interfaces, dispute resolution, or rule enforcement. A platform therefore need not be understood solely as a digital marketplace. The analytical category concerns the recurrent mediation of relations through a shared architecture.

Rochet and Tirole’s analysis of two-sided markets demonstrates one important mechanism: participation or surplus on one side can depend on participation on another, so a platform’s price structure and participation rules can influence whether the interaction system is viable (Rochet and Tirole 2003). GRE generalizes the relational lesson cautiously. Different platform configurations can connect more than

Table 12.17: Selected relational dimensions of platforms and infrastructures.

Dimension	Relational object	Illustrative analytical questions
Platform mediation	Interfaces, matching, ranking, settlement, participation rules, records, and governance connecting participant positions	Which interactions are mediated, through which mechanisms, and which decisions remain with participants or the mediator?
Infrastructure	Shared material, technical, institutional, informational, or organizational conditions supporting recurrent downstream activity	Which activities depend on the arrangement, and which parts of the condition are shared, substitutable, or difficult to replace?
Access	Eligibility, connectivity, discoverability, technical capability, transactional capacity, and redress	Who can practically use the platform or infrastructure, at which layer, and under which conditions?
Standards	Rules for formats, categories, interfaces, measurement, identification, quality, or protocol	Which forms of coordination do standards enable, and which actors bear adaptation or compliance costs?
Interoperability	Ability of heterogeneous systems, organizations, records, or participants to interact across boundaries	Which layers interoperate, with what translation, and does interoperability imply portability or substitutability?
Dependency	Reliance on access, interfaces, data, standards, coordination, or complementary resources	Which capacities become difficult to exercise when the arrangement changes or access is lost?
Gatekeeping	Control over entry, visibility, ranking, compatibility, certification, transaction channels, or rule interpretation	Which positions can condition participation and on what basis can those conditions be reviewed or changed?
Network effects	Changes in value or feasible interaction associated with adoption or participation by others	Which effects are direct, indirect, local, cross-side, or contingent on compatibility and complementary resources?
Transformation	Change in architecture, governance, standards, interfaces, scale, boundaries, or dependency structure	Which historical processes expand, integrate, fragment, modularize, replace, or repurpose the arrangement?

two participant positions, can rely on non-price conditions as well as prices, and can organize relations whose primary object is coordination, communication, logistics, identity, information, or technical compatibility rather than exchange alone.

A platform-mediated relation can therefore be represented at several levels. At the interaction level, the platform changes who can encounter whom and under which conditions. At the organizational level, it can allocate roles among users, providers, complementors, moderators, certifiers, or other participants. At the institutional level, its rules can classify conduct, define eligibility, specify dispute processes, or determine what records count as authoritative within the mediated environment. These levels can be analytically separated even when they are implemented within one organization or technical system.

Platform mediation also has an endogenous character. Participant behavior can change the information, rankings, queues, inventories, reputational records, or other states on which later mediation depends. The platform can consequently participate in a feedback process in which earlier interactions alter the conditions of later interactions. The importance of this feedback is an empirical question. In some systems it is central to participation and visibility; in others, the platform is closer to a relatively stable conduit.

Remark 12.67 (Mediation without total control). A mediating position can be economically consequential without controlling every action that occurs through it. Platform analysis should distinguish the conditions the mediator can set or modify from decisions, resources, obligations, and capabilities that remain distributed among participants and external institutions.

12.15.2 Infrastructure as a Relational Condition

Infrastructure becomes economically relevant when recurrent activity depends on comparatively persistent shared conditions. These conditions can be material, such as transport, energy, water, storage, or communication systems; technical, such as protocols or computing services; institutional, such as registries, payment arrangements, identification systems, or legal procedures; and informational, such as common classifications, records, or reference systems. The category is relational because an arrangement becomes infrastructural through the activities it enables and the dependencies it supports, not merely through its physical form.

Frischmann's demand-side account emphasizes infrastructure as a shared input capable of supporting heterogeneous downstream uses (Frischmann 2012). This perspective is useful for GRE because it shifts attention from the infrastructure object alone to the plurality of capacities and activities made possible through access to it. A communications network, public database, port, standard, or road system can matter economically through uses that its designers did not fully specify in advance. The same infrastructure can therefore participate in several sectors, organizations, communities, and scales simultaneously.

An infrastructural condition can also remain partially invisible during routine operation. Participants may experience the service or capability it supports without reconstructing the material maintenance, standards, labor, institutional authority, finance, monitoring, and repair required for its persistence. Disruption can reveal these dependencies by making previously background conditions practically salient. This does not mean that infrastructure is causally inactive when it is unnoticed. Its stabilizing effects can be strongest precisely when recurrent activity is able to proceed without continuous renegotiation of underlying conditions.

The infrastructural description should nevertheless remain selective. Treating every background condition as infrastructure would remove analytical discrimination. GRE therefore asks whether the condition supports sufficiently recurrent and heterogeneous downstream activity, whether its continuity or failure materially changes relevant capacities, and whether the shared dependency contributes explanatory content that would be missed by representing each downstream relation separately.

Remark 12.68 (Infrastructural relevance). Infrastructure is a role assigned relative to an inquiry and a set of downstream activities. The same arrangement can be infrastructural for one process, merely complementary for another, and irrelevant for

a third. The attribution should identify the dependency mechanism and the scale at which it operates.

12.15.3 Platform and Infrastructure Access

Access concerns the practical capacity to use, reach, or benefit from a platform or infrastructure under relevant conditions. Formal permission is only one component. Effective access can depend on connectivity, identity or eligibility, physical proximity, technical compatibility, language, price, credit, device or equipment availability, knowledge, time, visibility, organizational status, data rights, or the availability of complementary resources. Access can consequently differ substantially among participants even where nominal terms are uniform.

For platform-mediated architectures, access is often layered. One participant may be able to create an account but lack meaningful visibility; another may transact but lack access to relevant records or interfaces; a complementor may reach users but depend on approval for software interfaces; a seller may participate but face settlement delays that materially constrain working capital. Infrastructure access is similarly differentiated. Physical connection can coexist with unreliable service, insufficient capacity, prohibitive cost, weak legal entitlement, or the absence of complementary capabilities needed to make productive use of the connection.

This suggests that access should be reconstructed as a bundle of relations and capacities rather than a binary state. Relevant dimensions can include entry, connectivity, discovery, use, contribution, modification, data retrieval, interoperability, redress, portability, and exit. The importance of each dimension depends on the architecture and inquiry. A platform that mediates communication and a transport infrastructure may require very different access profiles even when both are widely available.

Proposition 12.69 (Layered access). *Access to platforms and infrastructures can be differentiated across eligibility, connectivity, visibility, technical capability, transactional capacity, information, redress, portability, and exit. Formal admission therefore provides incomplete evidence of effective economic access when other layers materially condition participation or use.*

Access can also be dynamically produced. Standards, pricing, subsidies, organizational support, training, new interfaces, interoperability arrangements, or changes in complementary infrastructure can expand practical access without altering formal membership rules. Conversely, technical change or revised standards can reduce effective access even when formal eligibility remains unchanged. This dynamic aspect becomes important when evaluating infrastructure transformation later in the section.

12.15.4 Standards and Interface Rules

Standards coordinate expectations concerning formats, identities, measurement, interfaces, quality, compatibility, safety, reporting, or procedure. They can reduce the need for repeated bilateral negotiation by establishing shared conditions under which heterogeneous participants or systems can interact. In platform and infrastructure settings, standards can shape which components connect, which records are recognized, which transactions can be processed, and which forms of evidence or performance become legible.

Classification and standardization also select what is represented. Bowker and Star show that standards and classification systems are embedded in information infrastructures and can shape visibility, categories, and interaction (Bowker and Star 1999). The relevant implication for GRE is not that standardization is intrinsically problematic. Standards can support large-scale coordination, interoperability, safety, comparability, and reliability. Their analytical significance lies in the way a standard simultaneously enables some relations and imposes adaptation, translation, exclusion, or maintenance requirements on others.

Standards can be public, private, professional, organizational, technical, legal, or hybrid. Their authority can derive from law, contractual adoption, technical necessity, installed use, procurement rules, professional recognition, market convention, or coordination among participants. A standard can therefore become practically binding without being legally mandatory, while a legally specified standard can have limited practical effect if implementation, monitoring, or complementary infrastructure is weak.

Interface rules are a particularly important subset because they govern the points at which participants or components interact with the architecture. Application programming interfaces, document formats, payment interfaces, identification protocols, logistical specifications, reporting schemas, and contractual procedures can all condition who can connect and what actions can be performed. Changes to interface rules can consequently redistribute adaptation costs, create new opportunities, or render earlier investments less useful.

Remark 12.70 (Standards as enabling and selective). A standard can expand coordination while simultaneously selecting categories, imposing adaptation costs, or privileging particular technical and organizational arrangements. Evaluation should therefore distinguish the coordination capacity generated by standardization from the distribution of costs, access, and control associated with the standard.

12.15.5 Interoperability Relations

Interoperability concerns the capacity of heterogeneous systems, organizations, records, or participants to interact across a relevant boundary. It can be technical, semantic, organizational, institutional, or procedural. Two systems may exchange data while interpreting categories differently; two organizations may share standards while lacking procedures for recognizing one another's decisions; two payment systems may be technically connectable while legal or contractual restrictions prevent practical use. Interoperability should therefore be specified by layer rather than treated as a single property.

Systems competition research shows that compatibility can affect adoption incentives and competitive dynamics when users benefit from connection to a wider installed base (Katz and Shapiro 1994). Within GRE, compatibility is one possible mechanism of interoperability, but the concepts are not identical. Compatibility can describe whether components can function together, whereas interoperability may additionally require translation, recognition, governance, and operational procedures across organizational or institutional boundaries.

Interoperability can expand feasible relations by reducing switching, translation, or coordination burdens. It can allow participants to combine complementary systems, move records, reach additional counterparties, or preserve some capabilities

when changing providers. Yet interoperability can also create new dependencies on shared standards, translation layers, certifiers, identity systems, or governance arrangements. The relevant question is therefore which relations become possible, which new control points are introduced, and how costs and responsibilities are distributed across the interoperating architecture.

Interoperability also differs from substitutability. Two systems can interoperate while serving different functions, and two substitutable systems can remain poorly interoperable. The distinction matters for dependency analysis. A participant may retain access to several interoperable services without possessing a realistic substitute for a particular infrastructural function.

Caution 12.71 (Interoperability and substitutability). Interoperability should not be used as evidence of substitutability without additional mechanism-specific support. The ability of systems to exchange information or coordinate operations does not establish that participants can replace one system with another at comparable cost, quality, legal standing, or functional scope.

12.15.6 Infrastructural Dependency

Dependency arises when a participant's capacities become contingent on continued access to, compatibility with, or support from a platform or infrastructure that is difficult to replace within the relevant horizon. The dependency can concern resources, connectivity, coordination, knowledge, identity, reputation, records, payment, technical capability, market access, or institutional recognition. It can be mutual, asymmetric, temporary, or historically cumulative.

Infrastructural dependency often develops gradually. Organizations can redesign workflows around a shared system, participants can accumulate records or reputation within one architecture, complementary investments can become specific to a standard, and counterparties can coordinate expectations around a common interface. Increasing returns and historically contingent adoption can make later switching more costly or less attractive than earlier switching, even when alternative technologies remain technically possible (Arthur 1989). Such path dependence is one possible mechanism rather than a universal outcome of infrastructure use.

Dependency should be distinguished from simple use frequency. A frequently used platform may be readily replaceable, whereas a rarely used infrastructural service can be indispensable during a critical event. GRE therefore reconstructs dependency through counterfactual capacity: what relevant activities, options, or relations become unavailable, delayed, more costly, or institutionally invalid if access changes? The answer can differ across participants because complementary resources and alternatives are unevenly distributed.

Dependency can also be distributed across layers. A business can avoid dependence on a particular application while remaining dependent on a payment network, identity system, technical standard, cloud layer, logistics system, or regulatory registry. Architecture-level analysis can therefore reveal dependencies that are obscured when attention is restricted to the most visible platform interface.

Remark 12.72 (Dependency as capacity contingency). The present framework treats infrastructural dependency as a relation between continued access to an architecture and the preservation of specified capacities over a stated horizon. Dependency does not by itself establish exploitation, domination, inefficiency, or normative undesir-

ability; those assessments require additional institutional, distributive, and normative analysis.

12.15.7 Gatekeeping and Access Control

Gatekeeping concerns positions that can condition entry, visibility, ranking, certification, compatibility, transaction, interface access, or continued participation in a platform or infrastructure. The gatekeeper can be an organization, administrator, technical protocol, professional body, regulator, standards organization, automated system, or combination of these. Gatekeeping is therefore a relational position defined by control over a consequential passage or condition, not by a particular organizational label.

Gatekeeping can serve several functions. Access controls can protect security, reliability, privacy, quality, safety, or resource integrity; certification can reduce information burdens; moderation can preserve usable interaction; and capacity allocation can prevent congestion or failure. These functions can coexist with substantial authority over who participates and under which conditions. The analytical task is to reconstruct both the capacity generated by gatekeeping and the dependencies, discretion, review mechanisms, and distributional effects associated with it.

Control can also be indirect. A platform can shape visibility through ranking rules without excluding participants formally. An infrastructure operator can alter compatibility requirements in ways that change participation costs. A standards body can determine which formats become recognizable. A payment intermediary can condition settlement without controlling the underlying sale. These cases demonstrate why access control cannot be inferred solely from ownership of the exchanged or transported object.

Gatekeeping becomes especially consequential where alternative routes are weak, switching costs are high, or the gated position controls a shared standard or infrastructure used by many downstream actors. The position can then affect the practical action space of participants even if individual transactions remain voluntary. Where relevant, analysis should identify how gatekeeping decisions are made, communicated, appealed, monitored, and revised.

Proposition 12.73 (Gatekeeping as relational control). *A gatekeeping position exists when an actor or mechanism can materially condition access to a consequential relation, interface, standard, visibility channel, or infrastructural capacity. The economic significance of that position depends on the importance of the gated capacity, the availability of alternatives, the distribution of switching costs, and the governance of gatekeeping decisions.*

12.15.8 Network Effects and Cumulative Adoption

Network effects arise when the value, usefulness, or feasible interaction associated with a product, service, standard, or platform depends partly on adoption or participation by others. The mechanism can be direct, where users benefit from interacting with additional users of a compatible system, or indirect, where participation on one side changes the availability of complements, counterparties, services, or participation on another side. Katz and Shapiro analyze these mechanisms in systems markets, while Rochet and Tirole develop related cross-side effects in two-sided platform

competition (Katz and Shapiro 1994; Rochet and Tirole 2003).

GRE treats network effects as mechanism-specific relational effects rather than a general property of networks. A network can exist without economically significant network effects, and network effects can vary by participant position, location, scale, quality, congestion, compatibility, or time. Additional participation can increase value for some actors while producing congestion, competition, moderation burdens, privacy costs, or reduced visibility for others. The sign and magnitude of the effect should therefore be established empirically for the relevant relation.

Cumulative adoption can interact with standards and dependency. An installed base can attract complementary investment, learning, service provision, or further users, while the resulting ecosystem can make alternative architectures less attractive or more costly to adopt. Arthur's analysis of increasing returns and historical lock-in provides one mechanism through which early events can shape later technology selection (Arthur 1989). GRE retains the historical insight while avoiding a presumption that lock-in necessarily follows. Multi-homing, interoperability, modularity, regulation, new standards, falling switching costs, or technological discontinuity can weaken cumulative advantage.

Network effects can also operate across layers of the architecture. The relevant object may be the user network, a complement ecosystem, a technical standard, an identity system, a payment network, or a body of interoperable records. Identifying the layer matters because interventions that change one network effect may leave another intact. A requirement for data portability, for example, may reduce one switching cost while leaving reputation, complement availability, technical integration, or participant expectations largely unchanged.

Remark 12.74 (Network effects as situated mechanisms). Network effects should be specified by participant position, mechanism, scale, and horizon. Their presence does not by itself establish monopoly, efficiency, welfare improvement, lock-in, or a particular policy conclusion.

12.15.9 Infrastructure Transformation

Platforms and infrastructures transform when their material components, standards, interfaces, governance, participant roles, access conditions, scale, or dependencies change sufficiently to alter the relations they support. Transformation can involve expansion, integration, fragmentation, modularization, replacement, repurposing, standard migration, organizational restructuring, public or private governance changes, or the emergence of new layers between participants and earlier infrastructure. The relevant unit of change should be defined by the mechanism under study rather than by assuming that an infrastructure transforms only when its physical assets are replaced.

Transformation can be path dependent because existing standards, installed equipment, organizational routines, records, complementary investments, and participant expectations condition which alternatives are feasible at a given time. It can also be discontinuous. A new technical interface, legal rule, organizational intermediary, or cross-system standard can reorganize access and dependency even when much of the physical infrastructure remains unchanged. Conversely, substantial investment in physical capacity may leave relational architecture largely intact if rules, access, and control remain stable.

Digital technologies illustrate how changes in search, replication, transportation, tracking, and verification costs can reorganize economic coordination (Goldfarb and Tucker 2019). The broader GRE point is technological rather than digital-essentialist: when the cost or feasibility of observing, connecting, copying, verifying, or coordinating changes, earlier relational boundaries and organizational forms can become less stable. Whether that change produces decentralization, concentration, new intermediaries, wider access, or new dependency remains an empirical question.

Transformation can also alter the status of an arrangement. A platform initially used for a narrow set of interactions can acquire infrastructural characteristics if heterogeneous downstream activities reorganize around its interfaces and continuity. An infrastructure can become more platform-like if access, matching, ranking, identity, and transaction governance are increasingly concentrated in a mediating layer. These are historical shifts in relational role rather than categorical conversions that can be inferred from terminology alone.

Proposition 12.75 (Relational transformation of infrastructural role). *An arrangement's platform or infrastructural role can change when the relations of mediation, shared use, dependency, standards, access, or governance through which downstream activities are organized change materially. The attribution should therefore be revisable across historical periods and analytical scales.*

Infrastructure transformation can generate both new capacities and new constraints. Interoperability can widen participation while creating reliance on common standards; integrated systems can reduce coordination burdens while increasing correlated failure or shared dependency; modular architectures can expand experimentation while shifting responsibility to interface governance; and new access channels can extend participation while generating additional gatekeeping positions. GRE therefore evaluates infrastructural change through the relational configuration it produces rather than through a general presumption that greater connectivity, standardization, integration, or scale is intrinsically preferable.

Platforms and infrastructures, on this account, are parts of economic architecture through which relations become connectable, repeatable, scalable, observable, and sometimes difficult to replace. Their economic significance arises from mediation, shared use, access, standards, interoperability, dependency, gatekeeping, network effects, and historical transformation. These dimensions also prepare the analysis of resources, capacities, constraints, and access by showing that what an economic subject can possess or do often depends on relational conditions that lie outside the subject itself.

12.16 Resources

Resources occupy a central place in economic description because production, provision, exchange, care, learning, mobility, organizational action, and institutional participation depend on conditions that can be mobilized for practical purposes. This section develops a Generative Relational account of resources as historically situated and relation-dependent economic objects. Its objective is to distinguish important resource forms while avoiding the assumption that resources are self-identifying stocks whose economic significance is independent of subjects, institutions, access conditions, technologies, or purposes. The discussion proceeds through material,

financial, temporal, spatial, informational, knowledge, attentional, infrastructural, institutional-access, and relational resources before examining resource convertibility. The method is conceptual and comparative: each resource form is characterized by the relations that make it usable and by the conditions under which apparent possession differs from effective mobilization. Table 12.18 summarizes the distinctions used in the section.

The distinction between aggregate availability and effective command over resources is well established in economic analysis. Sen's entitlement approach, for example, shows that aggregate food availability does not determine whether particular persons can command food through production, exchange, transfers, or legally recognized entitlements (Sen 1981). The capability approach further distinguishes possession of commodities or means from what persons are actually able to do or be with them, drawing attention to heterogeneous conversion conditions (Sen 1985; Robeyns 2005). GRE adopts the broader relational lesson without treating the capability framework as identical to GRE: the economic significance of a resource depends partly on the configuration through which it becomes accessible and convertible into relevant capacities.

Definition 12.76 (Economic resource). For a specified economic inquiry, an *economic resource* is a material, financial, temporal, spatial, informational, epistemic, attentional, infrastructural, institutional, or relational condition that a subject or configuration can potentially mobilize in forming, sustaining, transforming, or exercising an economically relevant capacity. Resource attribution is relative to the relevant subject, process, historical conditions, and mechanisms of access and use.

Definition 12.76 treats resourcehood as relational without making it purely subjective. A physical asset, monetary balance, database, transport system, credential, professional relation, or period of available time can exist independently of a particular intended use, yet its economic significance changes with access, compatibility, institutions, knowledge, timing, and complementary conditions. The same object can therefore function as a resource for one process while remaining unusable, inaccessible, or even constraining for another.

Proposition 12.77 (Relational resource attribution). *Resource attribution should identify both the object or condition being treated as a resource and the relational mechanism through which it can contribute to a specified capacity or process. Possession, availability, recognition, and effective mobilization may diverge.*

12.16.1 Material Resources

Material resources include physical and biological conditions that can enter economic activity as inputs, means of provision, productive equipment, energy, land, buildings, inventories, raw materials, ecological stocks, or other materially consequential objects. Their resource character depends on more than physical existence. A mineral deposit can be geologically present without being economically usable under available technology, law, infrastructure, energy conditions, knowledge, or cost structures. Equipment can be owned but unusable because complementary components, maintenance, trained operators, or electricity are absent. Food can exist in aggregate while particular households lack command over it, as entitlement analysis demonstrates (Sen 1981).

The relevant material description therefore depends on the process under study.

Table 12.18: Selected resource forms and their relational conditions.

Resource form	Illustrative economic object	Relational conditions requiring analysis
Material	Land, energy, equipment, biological materials, inventories, physical inputs	Access, quality, location, compatibility, maintenance, depletion, substitution, and rights of use
Financial	Money balances, liquid claims, credit lines, securities, borrowing capacity	Liquidity, denomination, settlement, collateral, creditworthiness, legal claims, and market access
Temporal	Available time, scheduling windows, waiting capacity, sequencing flexibility	Obligations, deadlines, synchronization, care burdens, institutional calendars, and delay
Spatial	Location, proximity, territorial position, physical reach, logistical placement	Transport, jurisdiction, accessibility, connectivity, congestion, and spatial exclusion
Informational	Data, signals, records, measurements, forecasts, classifications	Observability, quality, timeliness, interpretation, rights, provenance, and performative effects
Knowledge	Skills, know-how, theories, procedures, tacit understanding, organizational competence	Learning, embodiment, codification, transfer, interpretation, retention, and complementary experience
Attentional	Cognitive and organizational capacity to notice, select, interpret, and follow information	Information load, priorities, interruption, expertise, organizational allocation, and time
Infrastructural	Shared technical, material, organizational, or institutional support conditions	Access, standards, interoperability, continuity, dependency, governance, and maintenance
Institutional-access	Eligibility, recognized status, licences, credentials, procedural standing, entitlements	Classification, documentation, authority, enforcement, procedural access, and contestability
Relational	Trust, reputation, obligations, network position, reciprocal ties, cooperative histories	Recognition, maintenance, reciprocity, asymmetry, closure, brokerage, and institutional context
Convertibility	Capacity to transform one resource configuration into another economically relevant form	Conversion mechanism, loss, delay, asymmetry, complementarity, reversibility, and historical conditions

Mass, energy content, durability, location, divisibility, quality, perishability, substitutability, toxicity, renewability, and compatibility can matter differently across activities. GRE does not require a universal material-resource taxonomy. It asks which material properties enter the relational mechanism under investigation and which complementary relations make those properties economically consequential.

Material resources also possess histories. Infrastructure degrades, inventories turn over, soil quality changes, machinery accumulates wear, and biological resources reproduce or decline. Investment, maintenance, repair, extraction, pollution, replenishment, and technical redesign can therefore alter future resource conditions. A static

inventory can be informative for a particular question while remaining insufficient for problems in which maintenance, depletion, reproduction, or cumulative environmental change matters.

The boundary of a material resource may itself be contested or scale-dependent. A factory can be treated as a productive asset at one resolution, decomposed into machines and technical systems at another, and embedded within energy, logistics, labor, and ecological infrastructures at a wider scale. The appropriate boundary should follow the causal and practical question rather than the convenience of an accounting category alone.

12.16.2 Financial Resources

Financial resources consist of monetary balances, liquid claims, credit capacities, financial assets, borrowing arrangements, payment instruments, and other financially recognized positions that can support transactions, investment, buffering, or commitments. Their practical relevance depends on denomination, liquidity, settlement infrastructure, legal enforceability, collateral, creditworthiness, transaction costs, market conditions, and institutional recognition. A nominal monetary amount therefore does not by itself describe the economic capacities that the holder can exercise.

Financial resources can differ sharply in temporal and relational structure. Cash or immediately spendable deposits can support short-horizon commitments; an illiquid claim may represent substantial wealth while offering limited capacity to meet an urgent payment; a credit line can expand present action possibilities while generating future obligations; collateralized borrowing can transform ownership of one resource into conditional access to another. Financial resource analysis should therefore distinguish the value recorded in an account from the practical capacities available under the relevant institutional and market conditions.

Financial relations can also couple actors across time. Credit creates present access through claims on future repayment, while securities, insurance arrangements, pensions, and other contracts distribute claims, risks, and obligations across future events. These relations make finance especially sensitive to expectations, legal enforceability, counterparty conditions, and institutional continuity. The same contractual claim can therefore change in practical significance as confidence, regulation, market liquidity, or the position of counterparties changes.

GRE treats financial resources as one resource family among others. Financial means can purchase or mobilize many resources under some conditions, but monetary command does not create universal convertibility. Legal restrictions, scarcity, time, location, social relations, technical incompatibility, ecological limits, or unavailable knowledge can block financial substitution. This point becomes central in the discussion of resource convertibility in Subsection 12.16.11.

12.16.3 Temporal Resources

Time becomes an economic resource when the availability, sequence, duration, or flexibility of action conditions what a subject or configuration can practically do. Temporal resources include discretionary time, scheduling flexibility, response windows, waiting capacity, recovery periods, synchronization opportunities, and the ability to defer or accelerate commitments. These forms should be distinguished from clock

time as a neutral coordinate. Two actors can possess the same number of hours while facing very different temporal resources because their obligations, deadlines, care burdens, transportation requirements, institutional schedules, health, or coordination dependencies differ.

Temporal resource analysis is therefore relational. A one-hour interval can have different economic significance depending on whether counterparties, public offices, markets, transport systems, childcare arrangements, or technical systems are simultaneously available. The relevant resource can lie in synchronization rather than duration. Likewise, the capacity to wait can confer bargaining or strategic advantages when another party faces urgent liquidity, deadlines, expiring rights, or perishable goods.

Time can also be committed irreversibly or with substantial recovery costs. Training, caregiving, search, administrative compliance, commuting, maintenance, and coordination consume time that cannot always be recovered through additional financial expenditure. Temporal scarcity can therefore interact with income, household structure, infrastructure, institutional access, and labor relations in ways that make nominally identical choices practically different.

For GRE, temporal resources are especially important because economic histories are event ordered. Earlier commitments can close later options, delays can change the field to which a decision applies, and the value of a resource can depend on whether it becomes available before or after other events. Temporal analysis should therefore preserve sequencing and timing where they materially affect economic possibility rather than reducing time to an undifferentiated scalar input.

12.16.4 Spatial Resources

Spatial resources concern economically consequential location, proximity, reach, territorial position, mobility, and access to places in which resources, institutions, people, markets, infrastructures, or opportunities are situated. Space is not economically significant only as distance. Accessibility depends on the relation between locations and opportunities, including the transport, cost, time, institutional, and infrastructural conditions through which those opportunities can be reached (Hansen 1959).

A location can therefore function as a resource because it enables proximity to employment, customers, suppliers, schools, care networks, transport hubs, public services, ecosystems, cultural institutions, or regulatory jurisdictions. It can simultaneously impose costs through congestion, pollution, exposure, rent, jurisdictional restrictions, or vulnerability to disruption. Spatial resourcehood should be specified relative to the activity and subject under consideration.

Digital connectivity can transform spatial resources without eliminating spatial dependence. Remote communication can reduce some coordination costs while leaving logistics, energy, physical care, legal jurisdiction, time zones, embodied work, land use, and infrastructure geographically situated. Platform-mediated access can also make apparently remote resources contingent on data centers, networks, payment systems, language communities, or regulatory territories that remain spatially organized.

Spatial resources are often cumulative and path dependent. Infrastructure, land-use patterns, housing, institutional concentration, agglomeration, and historical investment can make some locations increasingly connected while others remain costly

to reach. GRE treats these patterns as relational configurations whose boundaries and relevant scale depend on the question, rather than assuming a single spatial unit such as the city, region, or nation.

12.16.5 Informational Resources

Informational resources include data, records, measurements, signals, classifications, forecasts, descriptions, and other representations that can reduce uncertainty, coordinate action, support evaluation, or make economic conditions observable. Information possesses economic properties that differ from many ordinary material goods. Arrow's analysis of invention and information emphasizes uncertainty and appropriation problems that complicate ordinary commodity treatment (Arrow 1962). In GRE, the additional concern is relational: information becomes a usable resource only when it can be accessed, interpreted, trusted sufficiently for the purpose, and connected to an action or learning process.

The quantity of information therefore does not measure informational resourcefulness. Large datasets can have low practical value when provenance is unknown, variables are poorly aligned with the inquiry, access is delayed, or interpretation is absent. A small amount of timely and well-contextualized information can be highly consequential. Informational resources should consequently be described through quality, relevance, granularity, timeliness, provenance, interoperability, interpretability, and rights of access where these dimensions matter.

Information can also be performative. A rating, forecast, eligibility category, risk score, market price, or public announcement may alter expectations and actions, thereby changing the field that the representation described. Information can therefore be both a resource for observation and an epistemic event that changes subsequent economic relations. The practical value of the information may depend partly on how other actors receive and act upon it.

Information is also unevenly distributed. Hayek's analysis of dispersed knowledge shows why coordination problems arise when relevant knowledge is distributed among actors rather than concentrated in one decision center (Hayek 1945). GRE extends the concern to the relations that determine which actors can observe, share, withhold, interpret, certify, or contest information. These positions can become resources or sources of dependency even without direct ownership of material assets.

12.16.6 Knowledge Resources

Knowledge resources include skills, know-how, conceptual understanding, procedural competence, tacit expertise, technical knowledge, organizational routines, and learned capacities that can support economic action. Human-capital analysis provides one established economic representation of acquired education and training as productive investment (Becker 1964). GRE retains the importance of learning and acquired competence while using a broader relational account that distinguishes possession of codified information from the ability to interpret, apply, adapt, teach, or combine it in a particular configuration.

Knowledge can be embodied in persons, distributed across teams, stabilized in routines, encoded in documents or software, incorporated in technical artefacts, or preserved through institutions and professional communities. These forms have differ-

ent transfer conditions. A manual may be copied rapidly while the practical competence required to use it develops slowly; tacit knowledge may require apprenticeship or recurrent interaction; organizational knowledge may depend on coordination among people who individually possess only fragments of the relevant process.

Knowledge resources are consequently vulnerable to loss through turnover, organizational restructuring, technological change, language discontinuity, destruction of archives, or weakening of communities of practice. Conversely, knowledge can accumulate through learning-by-doing, experimentation, research, teaching, collaboration, and recombination. The relevant economic resource may lie in the capacity to generate new knowledge rather than only in a stored body of existing knowledge.

Knowledge also interacts with authority and institutional recognition. A person can possess practical expertise without having the credential or organizational standing required to exercise it; a credential can grant access while only imperfectly representing competence. Knowledge-resource analysis should therefore distinguish epistemic capacity, recognized qualification, decision authority, and practical opportunity to apply knowledge.

12.16.7 Attentional Resources

Attention becomes an economic resource because observation, interpretation, learning, coordination, and decision require selective cognitive and organizational focus. Simon's analysis of information-rich environments emphasizes that an abundance of information consumes the scarce attention of recipients and therefore creates a problem of allocating attention among competing sources (Simon 1971). The GRE treatment includes individual attention but also extends to organizational and institutional arrangements that determine what becomes visible, prioritized, monitored, escalated, or ignored.

Attentional resources are not adequately described by total available time. Two organizations with similar staffing can differ in attentional capacity because reporting systems, incentives, expertise, interruptions, hierarchy, information architecture, or crisis load channel focus differently. A decision process can fail because relevant information never reaches the position capable of acting on it, because warning signals compete with routine reporting, or because the cost of sustained monitoring exceeds available organizational attention.

Attention is also relationally contested. Firms compete for consumer attention; political and administrative systems allocate attention among problems; managers allocate attention among units and indicators; digital interfaces rank and filter what users encounter. These arrangements can create gatekeeping positions over visibility even where the underlying information remains technically available.

The economic value of attention therefore depends on selection and context. More attention is not uniformly beneficial, and concentrating attention on one issue necessarily changes the attention available elsewhere. GRE treats attention as a scarce and allocable resource whose organization can generate both capacities and blind spots. The relevant inquiry should identify the mechanism through which attention affects action rather than treating attention as a universal scalar commodity.

12.16.8 Infrastructural Resources

Infrastructural resources are shared material, technical, organizational, informational, or institutional conditions that can support multiple downstream activities. Frischmann's demand-side account of infrastructure emphasizes the economic significance of resources that serve as inputs into heterogeneous productive and social uses (Frischmann 2012). GRE uses this insight in conjunction with the platform and infrastructure analysis developed earlier in the chapter: an infrastructural resource is important not merely because it exists, but because access to it enables a range of further relations and capacities.

Examples can include transport systems, energy networks, communication backbones, payment rails, legal registries, identity systems, shared scientific facilities, standards, databases, public spaces, and organizational support systems. Their resource character can be distributed. A participant may use an infrastructure without owning it, while ownership of an infrastructural asset may confer limited practical control when regulation, interoperability obligations, technical dependence, or joint governance constrain unilateral action.

Infrastructural resources often display complementarities and shared dependence. Their failure can therefore propagate across activities that appear otherwise unrelated. Conversely, infrastructural improvement can create new option sets by reducing coordination, transport, verification, search, or compatibility costs across many downstream processes. These effects should be identified empirically rather than inferred from the label "infrastructure."

Access conditions are especially important. A nominally public or technically open infrastructure can remain unevenly usable because of fees, location, disability, language, technical standards, credentials, devices, complementary services, or knowledge. The distinction between infrastructural availability and effective infrastructural access prepares a separate analysis of access as an economic relation and condition in its own right.

12.16.9 Institutional-Access Resources

Institutional-access resources consist of recognized statuses, entitlements, licences, credentials, procedural standing, legal capacities, administrative classifications, and other institutionally mediated positions that enable or condition participation in economic processes. These resources are relational because their practical effect depends on recognition by institutions and counterparties. A licence matters because specified authorities and participants treat it as authorizing conduct; a credential matters because organizations use it in admission, employment, or professional classification; an entitlement matters because institutions recognize a claim to provision, transfer, or access.

Sen's entitlement analysis provides a clear illustration of how legally and socially structured command over goods can diverge from aggregate availability (Sen 1981). North's institutional analysis likewise emphasizes how rules structure interaction and incentives (North 1990). GRE focuses on the access relation generated by such structures. The institutional resource lies neither solely in the text of a rule nor solely in an individual's attributes; it lies in the recognized position and the mechanisms through which that position can be exercised.

Institutional-access resources can be cumulative. Prior education can create eligibility for a credential; the credential can create eligibility for an occupation; employment can generate insurance, pension, credit, or residency consequences; recognized organizational status can create access to procurement, finance, or regulatory channels. These sequences make institutional resources historically path dependent even when each individual step is formally rule governed.

Institutional access can also be fragile. Documentation can expire, classifications can change, discretionary interpretation can vary, organizations can lose accreditation, or procedural barriers can make recognized rights costly to exercise. Analysis should therefore distinguish formal entitlement, administrative recognition, procedural usability, and realized access. The next sections on capacities, constraints, and access will build on this distinction.

12.16.10 Relational Resources

Relational resources arise from positions and histories within social, organizational, institutional, and economic relations. They can include trust, reputation, reciprocal obligations, information channels, cooperative experience, sponsorship, brokerage positions, shared norms, and access mediated through networks. Coleman analyzes social capital as resources embedded in social structure, including obligations and expectations, information channels, norms, and closure (Coleman 1988). Granovetter's embeddedness argument likewise demonstrates that economic action can depend materially on ongoing social relations rather than on atomized exchange alone (Granovetter 1985).

GRE treats relational resources as configuration-specific rather than as a universally positive stock of "social capital." A dense network can facilitate trust and coordination while also restricting entry, reinforcing conformity, or concentrating information within a closed group. A brokerage position can create valuable access across otherwise separated groups while making others dependent on the broker. Reputation can reduce transaction uncertainty in one field while being irrelevant or even constraining in another.

Relational resources also require maintenance. Trust can erode; obligations can be discharged or contested; network positions can change as actors enter, exit, or form new ties; organizational restructuring can dissolve channels through which information previously moved. A relational resource can therefore disappear without any obvious physical asset being destroyed. Conversely, repeated cooperation can generate relational capacities that were absent at the beginning of the interaction.

The distribution of relational resources is often uneven and historically cumulative. Family position, education, occupation, organizational membership, migration history, language, geography, discrimination, and prior institutional participation can shape which relationships are practically available. GRE does not infer normative legitimacy from these resources. It treats them as economically consequential relations whose mechanisms, accessibility, and distribution can be investigated.

12.16.11 Resource Convertibility

Resource convertibility concerns the conditions under which one resource form can be transformed, mobilized, or exchanged into another economically relevant

resource or capacity. Convertibility is central to economic architecture because many practical strategies depend on such transformations: financial resources purchase material inputs; time and attention contribute to learning; knowledge can support income generation; institutional recognition can open access to finance or occupations; relational resources can provide information or opportunities; infrastructure can make spatially distant resources practically reachable. These conversions are common, but they are neither automatic nor universally reversible.

The capability literature provides one useful precedent for treating conversion as heterogeneous: persons can obtain different functionings from similar commodity or resource bundles because personal, social, and environmental conversion conditions differ (Sen 1985; Robeyns 2005). GRE generalizes the analytical concern beyond person-level welfare. Conversion can depend on institutions, networks, technologies, timing, location, complementary resources, power, standards, and prior histories at individual, organizational, community, or system scales.

Proposition 12.78 (Situated resource convertibility). *The convertibility of a resource is conditional on a specified conversion mechanism and relational configuration. Conversion rates, losses, delays, reversibility, and accessible outputs can vary across subjects, positions, institutions, scales, and historical periods.*

Proposition 12.78 cautions against treating resource forms as universally commensurable. Financial wealth can often expand choice, yet it cannot instantly produce trusted relations, accumulated expertise, biological recovery, institutional legitimacy, or elapsed time. Knowledge can sometimes be monetized, but market demand, legal rights, organizational position, reputation, language, and complementary assets condition the conversion. A credential can improve occupational access while remaining weakly transferable across jurisdictions. A transport infrastructure can convert spatial separation into practical accessibility for some users while leaving others excluded by cost, disability, documentation, or service design.

Conversion can also be lossy and path dependent. Selling an illiquid asset under urgency may realize only part of its longer-horizon value; converting land to another use can destroy ecological or cultural capacities that are difficult to recover; reorganizing a community relation into a priced transaction can change expectations and obligations; using reputation to obtain short-term advantage can alter the trust that made the reputation valuable. Resource conversion can therefore modify the source relation as well as the destination resource.

Convertibility is frequently asymmetric. One resource may be readily converted into another while the reverse path is costly or unavailable. Money can purchase professional advice without creating the professional's accumulated experience in the purchaser; institutional authority can compel reporting without generating trust; attention can be directed toward learning, yet prior lost time cannot be reconstructed through later attention alone. These asymmetries make resource architecture more informative than a single aggregate measure of wealth or capital for many GRE questions.

Remark 12.79 (Resource plurality and analytical aggregation). GRE permits aggregation when a well-defined empirical or formal purpose justifies it. Aggregation should preserve the distinctions needed for the inquiry and should not imply that heterogeneous resources possess a universal conversion metric. Where conversion is conditional, asymmetric, delayed, or lossy, those conditions remain part of the economic explanation.

Resources are therefore neither isolated stocks nor merely labels applied to useful things. They are objects and conditions whose economic relevance is generated through relations of access, recognition, timing, compatibility, knowledge, infrastructure, and conversion. Material, financial, temporal, spatial, informational, knowledge, attentional, infrastructural, institutional-access, and relational resources can interact and partially transform into one another, yet the transformations depend on historically specific mechanisms. This resource architecture prepares the analysis of capacities and constraints by separating what is potentially mobilizable from what a subject or configuration can actually do under prevailing relational conditions.

12.17 Capacities and Constraints

Resources describe conditions that may be available for economic use, while capacities concern what subjects and configurations can actually do under prevailing relational conditions. Constraints concern the conditions that delimit, redirect, delay, condition, or make costly those possible actions and transformations. This section develops capacities and constraints as historically situated features of economic architecture rather than as fixed attributes attached independently to persons, organizations, or institutions. Its objective is to distinguish important loci of capacity and constraint while preserving their interaction across scales. The discussion proceeds through individual, collective, organizational, institutional, epistemic, and relational capacities, followed by material, institutional, and relational constraints and the transformation of constraints over time. The method is conceptual and comparative, drawing on capability, institutional, collective-action, organizational, and relational traditions where they clarify the economic mechanisms at issue. Table 12.19 summarizes the principal distinctions.

The distinction between resources and capacities is especially important. Research on capabilities has long emphasized that possession of commodities or resources does not determine what persons are substantively able to do or be, because conversion conditions differ across persons and environments (Sen 1985; Robeyns 2005). GRE adopts the broader analytical lesson while extending it beyond person-level welfare. A resource can contribute to capacity only through relations of access, compatibility, timing, knowledge, coordination, recognition, authority, and complementary support. Similar resource bundles can therefore support markedly different capacities across persons, organizations, communities, or institutions.

Definition 12.80 (Economic capacity). For a specified economic inquiry, an *economic capacity* is a historically situated ability of a subject or relational configuration to initiate, sustain, resist, coordinate, transform, or complete an economically consequential process under specified conditions. Capacity attribution should identify the relevant subject or configuration, the class of actions or transformations at issue, and the conditions under which the capacity can be exercised.

Definition 12.81 (Economic constraint). For a specified economic inquiry, an *economic constraint* is a material, institutional, relational, epistemic, temporal, technical, ecological, organizational, or other condition that changes the feasible, accessible, timely, or sustainable set of actions or transformations available to a subject or configuration. Constraint attribution is relative to the process, scale, time horizon, and counterfactual alternatives relevant to the inquiry.

Definitions 12.80 and 12.81 keep capacity and constraint analytically relational. A condition can support one capacity while constraining another. A licensing regime can restrict entry while creating recognized professional standing; a technical standard can narrow design choices while enabling interoperability; a budget can limit expenditure while supporting planning discipline; a contractual commitment can reduce short-run discretion while enabling longer-run coordination. GRE therefore treats constraints as structuring conditions whose practical significance must be specified rather than as synonymous with harm or deficiency.

Proposition 12.82 (Resource–capacity non-equivalence). *Resource availability does not by itself establish economic capacity. Capacity depends on the relations through which resources can be accessed, combined, converted, coordinated, interpreted, and exercised under relevant constraints.*

Proposition 12.82 provides the immediate bridge from Section 12.16. Financial resources can remain unusable where settlement infrastructure is unavailable; information can remain practically inert where interpretive capacity is absent; legal entitlement can fail to generate effective access where procedures are inaccessible; collective resources can fail to support coordinated action where trust, authority, or shared expectations have broken down. Conversely, strong capacities can sometimes be generated from modest resource stocks through organization, cooperation, knowledge, institutional access, or favorable timing.

12.17.1 Individual Capacity

Individual economic capacity concerns what a person can effectively do within a specified economic process under prevailing relational and historical conditions. Relevant capacities can include producing, learning, moving, negotiating, refusing, caring, saving, investing, organizing, communicating, changing occupation, making claims, or participating in institutions. The appropriate description depends on the inquiry. A labor-market analysis may focus on capacities for occupational entry, mobility, and bargaining; a household analysis may focus on provisioning and care; a financial analysis may focus on capacities to transact, absorb shocks, or obtain credit.

Capacity should not be inferred directly from nominal resources or formal rights. The capability approach provides a useful precedent for distinguishing means from substantive opportunities and for recognizing heterogeneous conversion factors (Sen 1985; Robeyns 2005). A person with nominal access to education may lack time, transport, language support, documentation, caregiving substitutes, or financial capacity to participate. A worker with a contractual right to resign can face practical limits created by debt, immigration status, health insurance dependence, geography, specialized credentials, or limited alternative employment. GRE therefore treats individual capacity as jointly constituted by personal conditions and surrounding relations without reducing it to either side.

Individual capacity is also temporally structured. Skills can accumulate or decay; health and energy can vary; caregiving obligations can change; institutional eligibility can expire; savings can provide temporary waiting capacity; repeated exclusion can narrow future options. An assessment at one moment can therefore miss the historical processes that generated the present capacity and the processes through which it may expand or contract.

The same person can possess strong capacity in one dimension and weak capacity

Table 12.19: Selected capacities and constraints in economic architecture.

Dimension	Illustrative analytical object	Questions requiring specification
Individual capacity	Action, refusal, learning, mobility, bargaining, care, production, adaptation	Resources, conversion conditions, health and embodiment where relevant, legal status, time, information, alternatives, and support
Collective capacity	Joint provision, coordination, mutual support, common governance, pooled action	Membership, complementarity, trust, coordination, contribution, distribution, authority, and free-riding or conflict conditions
Organizational capacity	Recurrent production, service delivery, coordination, adaptation, implementation	Roles, routines, authority, resources, knowledge, interfaces, redundancy, learning, and external dependence
Institutional capacity	Rule formation, recognition, adjudication, administration, enforcement, public provision	Legitimacy, jurisdiction, procedures, information, staffing, finance, compliance, coordination, and historical credibility
Epistemic capacity	Observation, interpretation, diagnosis, forecasting, learning, model revision	Data access, expertise, attention, representation, uncertainty, model plurality, feedback, and contestability
Relational capacity	Capacity produced through positions, ties, trust, obligations, brokerage, or coordinated histories	Network position, reciprocity, recognition, dependency, alternatives, maintenance, asymmetry, and institutional embedding
Material constraint	Physical, ecological, technical, spatial, energetic, or temporal limitation	Mechanism, substitutability, degradation, thresholds, complementarity, timing, and scale
Institutional constraint	Rule, classification, procedure, jurisdiction, standard, entitlement, or enforcement condition	Scope, authority, interpretation, compliance, contestability, path dependence, and differential incidence
Relational constraint	Dependency, exclusion, hierarchy, coordination burden, distrust, lock-in, conflict, or positional limitation	Relation form, affected position, alternatives, exit capacity, feedback, cumulative effects, and transformation pathways
Constraint transformation	Change in the conditions structuring feasible action	Intervention, innovation, learning, institutional change, collective action, resource conversion, redistribution, and unintended effects

in another. High income can coexist with little discretionary time; technical expertise can coexist with limited institutional standing; formal authority can coexist with weak relational trust. GRE consequently avoids compressing individual capacity into a single scalar unless a specific empirical purpose and defensible aggregation rule

justify doing so.

12.17.2 Collective Capacity

Collective capacity arises when coordinated relations among multiple participants make possible actions or transformations that are weakly available or unavailable to participants acting separately. Examples include mutual insurance, collective bargaining, common-resource governance, cooperative production, community provision, pooled investment, shared maintenance, emergency response, or coordinated standard setting. Collective capacity therefore depends on configuration as well as membership.

Research on collective action and commons governance demonstrates that coordinated capacity can arise under institutional arrangements more varied than a simple state-versus-private dichotomy (Ostrom 1990). For GRE, the relevant point is methodological: collective capacity should be reconstructed through the mechanisms that support joint action. These can include shared rules, monitoring, communication, trust, sanctioning, recognized leadership, distributed expertise, repeated interaction, common infrastructure, and expectations about reciprocal contribution.

Collective capacity does not imply equal participation or equal benefit. A group may act effectively while concentrating agenda setting in a small subset of members. A coalition may mobilize substantial resources while placing disproportionate burdens on less powerful participants. A supply network may achieve high productive coordination while creating fragile dependence on a few nodes. Analysis should therefore separate the existence of collective capacity from its internal distribution, governance, accessibility, and normative evaluation.

Collective capacity can also depend on external relations. Community action can require public legal recognition, financing, technical expertise, transport, or organizational partners. A labor coalition can depend on statutory rights and enforcement. A research consortium can depend on shared infrastructure and funding agencies. Collective capacity is therefore rarely closed within the collectivity itself; it can be generated through higher-order relations spanning institutions and scales.

12.17.3 Organizational Capacity

Organizational capacity concerns the ability of an organization to reproduce or transform coordinated activity across persons, roles, resources, routines, and external relations. Relevant capacities can include production, service delivery, adaptation, learning, implementation, monitoring, financing, negotiation, maintenance, and crisis response. Section 12.11 treated organizations as relational condensations; the present subsection focuses specifically on what those condensations make practically possible.

Organizational capacity depends on more than aggregate resources. Equipment, funds, personnel, and information can coexist with weak implementation where roles are unclear, authority is fragmented, routines conflict, knowledge is inaccessible, or external dependencies are poorly coordinated. Conversely, routines, redundancy, institutional memory, and distributed expertise can allow an organization to maintain performance under resource pressure. The relevant unit of analysis is therefore the configuration linking resources to coordinated action.

Complex organizations can exhibit capacity heterogeneity across internal units. A corporation can possess strong engineering capability and weak regulatory capability; a ministry can possess rule-making authority and limited administrative reach; a university can generate research while lacking capacity to transfer knowledge into a particular application. Near-decomposable and nested structures can help explain why capacity in one subsystem does not automatically transfer to another (Simon 1962).

Organizational capacity can be cumulative and path dependent. Repeated activity can generate tacit knowledge, routines, external credibility, supplier relations, technical infrastructure, and learned coordination. Reorganization can destroy some of these capacities even when formal assets remain. Capacity assessment should therefore include both visible resources and historically generated relational structures whose loss may only become apparent after disruption.

12.17.4 Institutional Capacity

Institutional capacity concerns the ability of institutional arrangements to perform economically consequential functions such as recognizing status, setting rules, administering procedures, coordinating expectations, adjudicating disputes, providing public goods, collecting information, enforcing obligations, or enabling collective action. Institutions can distribute these functions across many organizations, professions, technologies, and legal positions; institutional capacity should therefore not be reduced to the budget or staffing of one organization.

North's analysis of institutions as humanly devised constraints structuring interaction highlights the economic significance of rules and their evolution (North 1990). GRE extends the inquiry toward the capacity of institutional configurations to enact and reproduce those rules in practice. A formal entitlement possesses limited practical significance where administrative procedures cannot process claims, records are unreliable, responsible offices lack authority, or enforcement is absent. Conversely, stable expectations can sometimes be supported by informal practices even where formal codification is limited.

Institutional capacity is multidimensional. Legislative capacity, administrative capacity, adjudicative capacity, fiscal capacity, regulatory capacity, informational capacity, and coordinative capacity can develop unevenly. Strength in one dimension can also create constraints elsewhere: extensive monitoring capacity can improve compliance while increasing administrative burden; standardized classification can improve comparability while reducing sensitivity to heterogeneous cases; rapid discretionary action can improve responsiveness while weakening predictability or contestability.

Institutional capacity can therefore expand through both accumulation and redesign. Additional resources matter, but so can clarified jurisdiction, interoperable records, procedural simplification, professional competence, institutional trust, or improved relations among organizations. The same reform can increase one institutional capacity while reducing another, which makes explicit scope specification important.

12.17.5 Epistemic Capacity

Epistemic capacity concerns the ability of a subject or configuration to generate, access, interpret, compare, communicate, revise, and act upon knowledge relevant to an economic process. It can depend on data, measurement systems, expertise, theoretical models, historical records, attention, organizational memory, information channels, and the practical authority to use or challenge an interpretation. Epistemic capacity therefore links resources of information and knowledge to processes of judgment and learning.

Economic knowledge is often distributed across actors and locations. Hayek's classic discussion of dispersed knowledge emphasizes that relevant information can be local, incomplete, and unavailable to any single decision maker in centralized form (Hayek 1945). GRE retains this coordination problem while widening the analysis to the institutional and relational conditions through which dispersed knowledge becomes visible, translated, contested, or ignored.

Epistemic capacity is not equivalent to data volume. Large datasets can coexist with weak understanding where categories are poorly matched to the process, historical changes undermine comparability, models suppress relevant heterogeneity, or organizational incentives discourage revision. Conversely, situated expertise, small samples, qualitative evidence, or local observation can sometimes provide high diagnostic value. Appropriate epistemic capacity therefore depends on the problem and on the composition of methods. Domain-general methodological analysis elsewhere in GRE treats that composition as a situated and revisable problem rather than as a fixed hierarchy of methods.

Epistemic capacity is also performative in some settings. A forecast, classification, rating, or diagnostic model can alter expectations and behavior when actors respond to it. The capacity to know and the capacity to influence can therefore become entangled. Analysis should identify when representations remain primarily descriptive and when their institutional uptake changes the field that subsequent evidence will describe.

12.17.6 Relational Capacity

Relational capacity is capacity generated through positions and histories within relations rather than through isolated attributes alone. Trust can enable cooperation without continuous monitoring; reputation can facilitate access to counterparties; brokerage can connect otherwise separated groups; reciprocal obligations can provide support during shocks; recognized authority can coordinate action; repeated collaboration can generate shared routines and mutual interpretation. These capacities arise through relational configurations and can weaken when those configurations change.

The literature on embeddedness and social capital provides useful precedents for analyzing economic resources and possibilities located in social structure (Granovetter 1985; Coleman 1988). GRE treats relational capacity more broadly and cautiously. Dense ties can support information and cooperation while limiting entry or exposing participants to conformity pressures. Brokerage can create connectivity while concentrating dependence on an intermediary. Trust can reduce coordination costs while increasing vulnerability where it suppresses verification. The same relational

configuration can therefore generate multiple capacities and constraints simultaneously.

Relational capacity is often non-transferable. A person who moves across organizations or jurisdictions may lose the practical value of reputation, trust, informal knowledge, or reciprocal obligations that depended on a previous field. An organization entering a new market can possess financial and technical resources while lacking relationships needed for distribution, regulatory interpretation, recruitment, or local legitimacy. Capacity analysis should therefore identify the relations in which the capacity is instantiated and the conditions under which it travels.

Relational capacity can also be shared without being equally controlled. A professional community may collectively sustain standards from which members benefit while a smaller group controls certification. A platform ecosystem may generate broad matching capacity while platform governance determines access conditions. The existence, distribution, and control of relational capacity are separate analytical questions.

12.17.7 Material Constraints

Material constraints arise when physical, biological, ecological, technical, spatial, energetic, or temporal conditions shape the feasible set of economic actions. Examples can include limited land, equipment capacity, energy availability, travel time, climatic exposure, biological recovery, storage limits, transport bottlenecks, technical compatibility, or infrastructure degradation. The relevant constraint is the mechanism through which the material condition affects the process, rather than materiality in the abstract.

Material constraints can be hard at one horizon and transformable at another. A bridge capacity is fixed for a given day yet expandable through investment over several years. Biological recovery imposes timing conditions that financial expenditure may only partly alter. A technical incompatibility can constrain exchange until a standard or interface is redesigned. The distinction between current constraint and transformable constraint therefore depends on the time horizon and available transformation mechanisms.

Substitution also requires explicit analysis. A scarce input can be substitutable in one production process and indispensable in another. Alternative technologies can require different complementary infrastructure, skills, ecological inputs, or institutional approval. Treating material constraints as prices alone can therefore conceal technical and relational conditions that determine whether substitution is actually feasible.

Material constraints can generate distributional differences. The same heat event, transport disruption, energy shortage, or spatial barrier can affect subjects differently according to housing, income, infrastructure, health, occupational role, location, or institutional access. A system-level material constraint should therefore not automatically be inferred to impose a uniform subject-level constraint.

12.17.8 Institutional Constraints

Institutional constraints arise through rules, norms, classifications, procedures, jurisdictions, standards, entitlements, enforcement practices, and expectations that shape

accessible economic action. Such constraints are central to institutional economics, where institutions structure interaction and incentives (North 1990). In GRE, institutional constraint is interpreted relationally: the same rule can create different practical constraints across positions because subjects differ in status, resources, information, procedural capacity, and available alternatives.

Institutional constraints frequently have enabling dimensions. Property registration constrains transfer through formal procedure while enabling recognized claims; accounting standards constrain representation while supporting comparison; professional licensing narrows entry while creating recognized competence categories; procurement rules restrict discretion while supporting procedural predictability. Analysis should therefore state which capacity is constrained and which capacities, expectations, or protections the same institution may help generate.

Institutional constraint can also operate through classification. Eligibility categories, occupational statuses, organizational forms, credit ratings, or regulatory classifications can determine which rules apply and which opportunities become accessible. Because classifications can be performative, institutional constraints may change behavior before formal enforcement occurs, particularly when actors anticipate future treatment.

Institutional constraints are historically revisable. Rules can be amended, reinterpreted, circumvented, ignored, or transformed through practice. Their practical durability depends on legitimacy, enforcement, administrative capacity, coordination, and expectation. A constraint can remain formally unchanged while becoming weaker or stronger in effect as surrounding institutions and relations evolve.

12.17.9 Relational Constraints

Relational constraints arise when a subject's feasible actions are conditioned by positions within relations of dependency, authority, obligation, trust, conflict, exclusion, coordination, or network structure. A firm can be technically capable of switching suppliers yet remain constrained by certification, compatibility, long-term contracts, accumulated learning, or customer expectations. A worker can possess transferable skills yet face occupational constraints through credential recognition, geography, care obligations, or immigration status. A household can own an asset while being constrained in its use by debt, co-ownership, social obligations, or institutional rules.

Relational constraints are often asymmetric. Dependence can be mutual while the cost of disruption differs sharply across participants. Authority can coordinate joint action while limiting unilateral discretion for subordinate positions. Trust can enable exchange while making verification socially costly. Network closure can support reputation and sanctioning while limiting access for outsiders. These examples make it useful to specify the affected position rather than describing the relation itself as uniformly constraining.

Relational constraints can also be emergent. No participant may individually impose a coordination bottleneck, yet the interaction among standards, routines, expectations, contracts, and installed infrastructure can make alternative action costly. Such constraints can persist even after the original reasons for a configuration have weakened because accumulated complementarities and expectations stabilize the existing path.

Remark 12.83 (Constraint and normative evaluation). Calling a condition a con-

straint identifies its role in structuring feasible action for a specified inquiry. It does not by itself establish that the constraint is undesirable. Some constraints protect rights, support coordination, reduce harmful action, preserve resources, or create predictable expectations. Other constraints can generate exclusion, domination, fragility, or avoidable loss. Normative evaluation requires additional criteria and situated analysis.

12.17.10 Constraint Transformation

Constraint transformation concerns changes in the conditions that structure feasible economic action. Constraints can be relaxed, intensified, displaced, redistributed, internalized, externalized, or converted into different forms through technical innovation, institutional change, collective action, learning, investment, migration, organizational redesign, resource conversion, political decision, or ecological change. The transformation of one constraint can simultaneously create another.

Technical change provides a simple illustration. A digital communication system can reduce spatial and coordination constraints while increasing dependence on electricity, connectivity, standards, cybersecurity, identity systems, or platform governance. Financial innovation can relax liquidity constraints while creating new informational or systemic dependencies. A new transport link can expand labor-market access while changing land values, commuting patterns, congestion, and local ecological pressure. Constraint transformation is therefore better treated as reconfiguration than as simple removal.

Institutional reform can have similar effects. Simplifying a licensing process can reduce entry burdens while increasing the importance of ex post monitoring. Expanding eligibility for a benefit can reduce income constraints while increasing administrative demand. Decentralization can reduce one form of centralized bottleneck while increasing coordination burdens across jurisdictions. These changes should be evaluated across the relevant positions, scales, and time horizons rather than through a single aggregate measure of constraint reduction.

Capacities and constraints can also co-evolve. A capacity developed to address one constraint can alter the future structure of constraints. An organization that develops sophisticated compliance capacity may gain access to highly regulated markets while becoming dependent on specialized administrative systems. A community that creates effective commons governance can generate collective capacity while also establishing membership obligations and boundary rules. A state that expands informational capacity can administer programs more effectively while creating new questions about classification, surveillance, and contestability.

Proposition 12.84 (Capacity–constraint coevolution). *Economic capacities and constraints can co-evolve because exercising or expanding a capacity can modify the relations that define later feasible action, while constraints can induce learning, coordination, substitution, institutional development, or other capacity-forming responses. The direction and normative significance of this coevolution remain empirical and historically situated questions.*

Proposition 12.84 cautions against treating capacity expansion as a simple movement toward unconstrained action. Economic action always occurs within some structure of material, institutional, temporal, ecological, and relational conditions. The analytical task is therefore to identify which capacities are generated, who

can exercise them, which constraints are transformed or displaced, and what new dependencies or possibilities emerge through the transformation.

Capacities and constraints jointly describe the practical architecture through which resources become economically consequential. Individual, collective, organizational, institutional, epistemic, and relational capacities are generated through different combinations of resources and relations, while material, institutional, and relational constraints shape the actions through which those capacities can be exercised. Their coevolution provides the immediate basis for a more focused analysis of access: the existence of a capacity or resource does not establish who can actually reach, claim, activate, or benefit from it under prevailing economic relations.

12.18 Economic Access

Economic architecture can contain resources, institutions, infrastructures, knowledge, networks, and decision processes whose practical significance depends on whether relevant subjects can actually reach, use, invoke, participate in, or influence them. This section develops *economic access* as the relational condition linking nominal availability to effective economic participation and capacity. Its objective is to distinguish several recurrent access mechanisms without reducing access to a single scalar measure or treating greater access as an unconditional normative good. The discussion proceeds through access to resources, institutions, knowledge, infrastructure, networks, and decision-making, followed by differentiated and mediated access and the transformation of access conditions. The method is conceptual and comparative. Capability, institutional, network, infrastructure, and information traditions are used where they clarify the mechanisms through which nominally available objects become practically usable. Table 12.20 summarizes the principal dimensions.

Access is analytically distinct from existence, ownership, entitlement, capacity, and realized use. A resource can exist without being reachable; a legal entitlement can exist without being procedurally usable; information can be publicly available without being interpretable; an infrastructure can be physically present without being affordable or technically compatible; a network can be extensive while remaining inaccessible to a particular actor; and a decision process can formally invite participation while offering little practical influence. Conversely, access can sometimes exist through informal, mediated, temporary, shared, or contingent arrangements even where formal ownership or membership is absent. These distinctions make access a relational property of an economic configuration whose meaning depends on the conditions of reachability and practical use.

Definition 12.85 (Economic access). For a specified economic inquiry, *economic access* is the historically situated practical relation through which a subject or configuration can reach, invoke, use, participate in, draw upon, or exercise influence over an economically consequential resource, institution, body of knowledge, infrastructure, network, or decision process under specified conditions. An access claim should identify the object of access, the relevant subject or configuration, the mechanism of access, the conditions of continued usability, and the time horizon of the claim.

Definition 12.85 treats access as more than a binary state. Access can vary in depth, reliability, timing, cost, quality, discretion, continuity, and dependence on intermedi-

aries. A person can possess emergency access to a resource without stable long-term access; an organization can use an infrastructure while lacking control over its interface; a community can have nominal participation rights while lacking timely information needed to exercise them; and an actor can enter a network while remaining peripheral to the relations through which opportunities are generated.

Proposition 12.86 (Availability–access non-equivalence). *The availability or formal existence of an economically relevant object does not by itself establish effective access to it. Effective access depends on the relational conditions through which the object can be reached, recognized, interpreted, afforded, combined, invoked, or used within the relevant time horizon.*

Proposition 12.86 extends the means-versus-capability distinction associated with capability-oriented analysis. Sen’s treatment of substantive freedom and Robeyns’s account of conversion factors both emphasize that nominal means do not uniquely determine effective opportunities (Sen 1999; Robeyns 2005). GRE applies this lesson more broadly to economic architecture. The relation between an available object and an effective capacity is mediated by access conditions, while access itself can depend on other resources, capacities, institutions, and relations.

Table 12.20 should be read as an open and revisable analytical repertoire. Several dimensions can apply simultaneously, and the relevant form of access depends on the problem. Access to credit, for example, can involve financial resources, institutional eligibility, information, network reputation, digital infrastructure, and a decision process through which an application is classified. A study that reduces the problem to one dimension can therefore miss the mechanism that actually determines practical access.

Remark 12.87 (Access and normative evaluation). GRE does not treat greater access as an unconditional good. Some forms of access may be harmful, coercive, unsafe, environmentally damaging, or inconsistent with other situated commitments. The analytical task is first to identify how access is produced and distributed; normative evaluation requires additional specification of the relevant subjects, consequences, values, rights, responsibilities, and alternatives.

12.18.1 Access to Resources

Access to resources concerns the conditions under which material, financial, temporal, spatial, informational, attentional, infrastructural, institutional, or relational resources can be practically mobilized. Resource existence and resource access are therefore distinct analytical questions. A public facility can exist at a geographic location while remaining inaccessible because of distance, cost, opening hours, disability, documentation, language, or transport. Financial wealth can exist in an illiquid form while offering little immediate capacity to meet an urgent payment. Shared resources can exist within a household or organization while control over their use remains uneven.

Resource access can be direct or conditional. Direct access can involve possession, recognized entitlement, or immediate use. Conditional access can depend on price, approval, collateral, membership, contribution, reciprocity, queuing, scheduling, or compliance with a technical or administrative requirement. These mechanisms differ economically because they distribute waiting time, uncertainty, bargaining position, future obligations, and the possibility of refusal in different ways.

Table 12.20: Selected dimensions of economic access.

Dimension	Illustrative access mechanism	Questions requiring specification
Resource access	Possession, entitlement, purchase, sharing, borrowing, allocation, claim, or conversion	Availability, recognition, affordability, timing, divisibility, complementary inputs, conversion conditions, and continuity
Institutional access	Eligibility, recognized status, documentation, standing, procedural entry, administrative recognition	Jurisdiction, classification, information, language, cost, waiting time, procedural burden, enforcement, and contestability
Knowledge access	Observation, education, documentation, transmission, interpretation, expertise, consultation	Availability, intelligibility, attention, language, tacit knowledge, uncertainty, credibility, and capacity to act on knowledge
Infrastructure access	Physical connection, technical interface, service eligibility, shared use, interoperability	Coverage, reliability, price, compatibility, standards, congestion, maintenance, quality, alternatives, and temporal availability
Network access	Membership, referral, tie formation, brokerage, repeated participation, reputation	Entry conditions, position, tie quality, reciprocity, trust, gatekeeping, closure, alternatives, and maintenance
Decision access	Voice, representation, agenda access, information rights, deliberation, authorization, review, appeal	Standing, timing, information, authority, procedural position, effective influence, accountability, and implementation
Differentiated access	Uneven access across positions, groups, places, times, and relational histories	Distribution, conversion conditions, cumulative advantage, burden, exposure, alternatives, and persistence
Mediated access	Broker, platform, credential, classification, professional intermediary, institution, technical interface	Mediator authority, dependence, fees, opacity, ranking, discretion, accountability, substitutability, and exit
Access transformation	Institutional change, infrastructure, learning, standardization, redistribution, technical redesign, network restructuring	Who gains or loses access, new dependencies, temporal effects, feedback, path dependence, and reversibility

The capability perspective is useful here because it distinguishes resources from the substantive opportunities that can be generated from them (Sen 1999; Robeyns 2005). GRE extends the analysis by making the access relation itself explicit. Two subjects can face the same nominal resource offer while differing in liquidity, information, time, documentation, complementary infrastructure, social support, or institutional standing. Their effective access can therefore differ before any further difference in resource conversion is considered.

Resource access is also temporally structured. Emergency access, temporary access, recurring access, secure long-term access, and contingent access provide different practical capacities. A short-term credit facility may bridge a liquidity gap while creating future repayment constraints. Temporary housing can provide immediate shelter while offering little long-term locational stability. Time-limited data access can support one analysis while preventing later verification. Access analysis should therefore specify duration, renewal conditions, and the consequences of interruption where these matter.

Finally, access can depend on combinations of resources. Money can purchase transport only where transport exists; institutional entitlement can be exercised only where information and administrative capacity are available; network membership can yield opportunities only where actors have time and knowledge to use them. Resource access is consequently often configurational and should be analyzed through the combination of enabling conditions that make use possible.

12.18.2 Access to Institutions

Access to institutions concerns the practical ability to invoke, enter, use, contest, or be recognized within rule-governed arrangements. Institutions structure economic action through classifications, rights, duties, procedures, standards, enforcement, and expectations. North's institutional analysis emphasizes the role of formal and informal constraints in structuring interaction (North 1990). For access analysis, the important question is how those structures become usable or binding for differently situated subjects.

Institutional access can depend on eligibility, jurisdiction, recognized identity, documentation, credentials, procedural standing, language, fees, waiting periods, deadlines, information about available procedures, and the practical capacity to comply with administrative requirements. Formal entitlement can therefore coexist with weak practical access. A benefit may exist in law while application procedures, proof requirements, administrative delay, or lack of information make uptake difficult. A court or dispute-resolution procedure may be formally open while cost, time, representation, or evidentiary burdens affect effective use. A professional license can create access to an occupation while making entry conditional on training, examination, fees, recognition of prior credentials, and continuing compliance.

Institutional access can also be mediated by classification. Recognition as an employee, resident, student, creditor, owner, dependent, licensed professional, eligible beneficiary, or qualified supplier can open or close a set of economic relations. Because classification can alter recognized rights, obligations, and opportunities, access analysis should examine both the rule and the process through which a subject is placed within the relevant category.

Access to institutions is not exhausted by successful entry. Effective use can depend on procedural continuity, timely response, understandable communication, appeal, correction of records, and the capacity to contest an adverse determination. Where an institution allocates scarce resources or permissions, access can also depend on queues, priority rules, discretion, or competition among applicants. These features make institutional access an ongoing process whose conditions can continue to change after entry.

12.18.3 Access to Knowledge

Access to knowledge concerns the relations through which economically consequential information, expertise, interpretation, and know-how become available and practically usable. The distinction between information and knowledge matters. Information can be recorded and transmitted while interpretation depends on concepts, expertise, context, language, experience, and the ability to distinguish relevant signals from noise. Hayek's analysis of dispersed knowledge remains useful for showing that economically relevant knowledge can be distributed across actors and contexts (Hayek 1945).

Knowledge access therefore involves more than publication or disclosure. It can depend on education, documentation, language, professional communities, tacit apprenticeship, data infrastructure, search capability, trusted intermediaries, and time for interpretation. Technical documentation can be openly published yet unusable without specialized background. A worker can know that a legal right exists while lacking the procedural knowledge required to exercise it. A firm can possess large data sets while lacking the expertise or attention required to identify a relevant pattern.

Attention is a particularly important access condition. Simon's observation that information abundance creates a scarcity of attention helps explain why nominal information availability can coexist with weak practical access (Simon 1971). Search, ranking, filtering, curation, and organizational routines therefore affect which knowledge becomes cognitively and institutionally accessible. These mechanisms can enable action while also privileging some representations over others.

Knowledge access can also be relationally unequal because some knowledge remains tacit, confidential, proprietary, localized, or embedded in practice. Network position can affect early access to information; organizational hierarchy can affect which reports are visible; professional status can affect whose interpretation is treated as credible. Epistemic quality should be evaluated independently of access position. The distribution of knowledge access remains economically consequential where it changes opportunity, bargaining, coordination, or the interpretation of uncertainty.

12.18.4 Access to Infrastructure

Access to infrastructure concerns the practical ability to use shared material, technical, organizational, or institutional systems that support heterogeneous downstream activity. Frischmann's demand-side account of infrastructure is relevant because it emphasizes infrastructures as shared inputs into multiple productive and social uses (Frischmann 2012). GRE focuses here on the access relations through which those shared conditions become available to particular subjects and processes.

Physical proximity does not determine infrastructural access by itself. Hansen's classic formulation of accessibility as a relation between locations and opportunities illustrates why reachability depends on more than geometric distance (Hansen 1959). Transport, energy, communications, payments, logistics, data, health, education, and other infrastructures can require connection, affordability, compatible equipment, recognized service status, technical literacy, reliability, and sufficient quality. A broadband network can pass a building without providing affordable usable connec-

tivity; a transport network can exist while schedules or fares make an opportunity practically unreachable; a payment rail can be technically available while identity or account requirements prevent participation.

Infrastructure access is often layered. One layer concerns physical or technical connection. Another concerns service eligibility. A third concerns reliability and quality. A fourth concerns the downstream applications that can be reached through the infrastructure. These layers can fail independently. Formal connection can therefore coexist with unstable service, congestion, low quality, or lack of interoperable downstream services.

Access conditions can also create dependency. If a subject reorganizes production, communication, mobility, or finance around one infrastructural system, interruption can become increasingly costly. This does not make dependence inherently undesirable; shared infrastructure often creates substantial collective capacity. It does mean that access analysis should include continuity, substitutability, governance, and recovery where interruption would materially alter the feasible action set.

12.18.5 Access to Networks

Access to networks concerns entry into and position within recurrent relations through which information, opportunities, trust, referrals, resources, coordination, or recognition can travel. Granovetter's embeddedness argument shows how economic action can depend on ongoing social relations (Granovetter 1985); Powell's analysis of network forms likewise demonstrates that recurrent relational structures can coordinate economic activity through mechanisms distinct from pure market or hierarchical forms (Powell 1990). Access to such structures can therefore have economic consequences even where no formal membership right exists.

Network access has at least two dimensions. The first concerns entry: whether a subject can form a tie, join a group, participate in a professional community, reach a broker, or become recognized by relevant actors. The second concerns position: what can actually be reached once entry occurs. Two actors can belong to the same network while differing substantially in centrality, brokerage, tie strength, reputation, reciprocity, and access to consequential parts of the network.

The economic value of network access is also conditional. A dense network can support trust and coordination while limiting exposure to alternative information. Brokerage can create access across otherwise separated groups while increasing dependence on intermediaries. Strong ties can provide reliable support while weak ties can sometimes connect actors to different information or opportunities. GRE therefore avoids treating network connectivity as a monotonic measure of advantage.

Network access can be cumulative. Existing ties can generate reputation or referrals that make further ties easier to form. Conversely, exclusion from early opportunities can reduce the probability of later recognition. Such processes can create path-dependent access patterns even without a single actor intentionally designing them. Empirical analysis should therefore distinguish current network position from the historical processes through which that position emerged.

12.18.6 Access to Decision-Making

Access to decision-making concerns the practical relations through which subjects can receive relevant information, present claims, contribute knowledge, influence agendas, participate in deliberation, authorize action, challenge a determination, or affect implementation. This dimension matters economically because decisions about allocation, standards, investment, employment, membership, infrastructure, classification, and organizational strategy can reshape later access and capacity.

Decision access should be disaggregated. Presence in a meeting is different from agenda-setting power; consultation is different from authorization; voting is different from control over implementation; the right to submit information is different from having that information considered; formal representation is different from the practical ability to communicate with representatives. The relevant access mechanism depends on the decision process being studied.

Access also has a temporal dimension. Information provided after a practical deadline offers different decision access from information available before agenda formation. An appeal that occurs only after irreversible implementation can have a different practical function from review that can suspend an action. Timing can therefore determine whether participation changes the feasible decision set or merely records disagreement after the fact.

GRE treats the appropriate depth and form of participation as situation-dependent. Specialized expertise, delegated authority, confidentiality, emergency conditions, scale, and transaction costs can make different decision arrangements appropriate under different circumstances. The analytical requirement is narrower: where decision access is economically consequential, the study should identify who can enter which stage of the process, through what mechanism, with what information and authority, and with what possibility of review or contestation.

12.18.7 Differentiated Access

Economic access is frequently differentiated across subjects, positions, places, times, organizations, and relational histories. Differentiation can arise through resource distribution, eligibility rules, infrastructure, price, language, knowledge, network position, organizational role, geography, technical compatibility, caregiving obligations, or accumulated reputation. Equal formal rules can therefore produce different effective access where conversion conditions differ.

Differentiated access can be horizontal or vertical. Horizontal differentiation occurs where actors have access to different resources, institutions, or networks without a clear ordering among them. Vertical differentiation occurs where some positions provide systematically broader, more reliable, cheaper, or more influential access than others along a relevant dimension. The distinction matters because heterogeneous specialization does not automatically imply hierarchy, while unequal control over consequential access points can generate durable asymmetry.

Access differentiation can also accumulate over time. Early institutional recognition can create access to education, employment, credit, or networks; those later positions can generate further resources and recognition. Conversely, an access interruption can produce losses that persist after the original barrier is removed. The analysis should therefore distinguish contemporaneous access gaps from historically

compounded access trajectories.

Normative conclusions require additional specification. Differentiated access may sometimes reflect functionally relevant specialization, safety requirements, scarcity, professional competence, or other situated considerations. In other cases it may reflect exclusion, capture, inherited privilege, administrative friction, or avoidable design choices. GRE's analytical task is to reconstruct the mechanisms, incidence, consequences, alternatives, and historical formation before assigning normative status.

12.18.8 Mediated Access

Many access relations operate through mediation. Brokers, platforms, professional intermediaries, public agencies, credentials, classification systems, technical standards, search systems, rankings, and organizational gatekeepers can connect subjects to resources or opportunities that would otherwise be difficult to reach. Mediation can reduce search costs, verify information, translate rules, coordinate interfaces, pool demand, standardize transactions, or provide trust where direct interaction would be costly.

Mediation also changes the structure of access. The intermediary can acquire discretion over admission, visibility, ordering, certification, pricing, timing, or the conditions under which parties encounter one another. A platform can enable broad market participation while controlling ranking and interface rules. A credential can make expertise legible while excluding forms of competence that the credential does not recognize. A broker can connect separated networks while becoming a critical passage between them. These effects do not determine a single normative judgment, but they make the mediator part of the access architecture.

Proposition 12.88 (Mediated-access dependence). *Where practical access to an economically consequential object recurrently depends on a mediator, changes in the mediator's rules, classifications, interfaces, prices, or availability can alter the downstream capacities of subjects even when the underlying object remains otherwise unchanged.*

Proposition 12.88 is intentionally conditional. The significance of mediation depends on alternatives, substitutability, switching costs, transparency, accountability, interoperability, and the depth of dependence. Where several comparable mediators exist, the practical effect of one intermediary's decision can be limited. Where access is concentrated through a difficult-to-replace interface, small rule changes can have large downstream consequences.

Mediated access can also obscure responsibility. A denial may appear to arise from an impersonal classification while the relevant rule was designed, selected, interpreted, or maintained by identifiable organizations. Conversely, an intermediary can be constrained by upstream legal, technical, contractual, or infrastructural conditions. Responsible analysis therefore traces the chain of mediation and distributes causal attribution across the relevant upstream and downstream conditions.

12.18.9 Transformation of Access Conditions

Access conditions can change through institutional reform, redistribution, infrastructure investment, organizational redesign, education, technical innovation, standardization, interoperability, network formation, new mediation, collective action, or changes in classification and recognition. Access transformation is therefore

one mechanism through which economic architecture changes without requiring immediate transformation of the underlying resource itself.

An access intervention can operate at several points. It can expand the supply or geographic reach of an object; change eligibility or procedural requirements; reduce price or waiting time; provide complementary knowledge or infrastructure; redesign an interface; create portability or interoperability; establish a new intermediary; strengthen alternatives; or change the authority through which access decisions are made. These interventions can produce different relational consequences even where they generate similar short-run participation rates.

Access expansion can also create new dependencies. Digitalization can reduce geographic barriers while increasing dependence on identity systems, software, connectivity, or platform governance. Standardization can improve interoperability while narrowing acceptable formats. Centralized provision can improve reliability while concentrating control. Informal mediation can increase reach while making access dependent on brokers. The relevant evaluation therefore concerns the transformed configuration, including the capacities and constraints that accompany the new access relation.

Transformation can be path dependent. Once organizations and households reorganize around an access channel, later changes to that channel can have consequences that were absent when it was introduced. Earlier exclusion can also leave residual effects through lost learning, reputation, savings, health, trust, or network position. Restoring formal eligibility may therefore fail to recreate the capacity that would have existed under uninterrupted access.

Proposition 12.89 (Access transformation and relational reconfiguration). *A change in economic access can reconfigure later capacities, dependencies, expectations, and relations even when the nominal resource, institution, or infrastructure remains unchanged. The significance of an access reform therefore depends on both immediate reachability and the subsequent relational processes it enables or constrains.*

Proposition 12.89 places access within the broader generative architecture of GRE. Access is neither a terminal outcome nor a sufficient measure of welfare, justice, or effectiveness. It is one condition through which resources, institutions, knowledge, infrastructure, networks, and decision processes become practically consequential. Analysis of later economic structures therefore benefits from preserving the distinction between what exists, who can access it, what capacities that access supports, and which new relations are generated through its use.

Remark 12.90 (Revisable access attribution). An access claim is an analytical commitment tied to a specified object, subject, mechanism, scale, and time horizon. Evidence that a formally available object is practically unusable, or that an apparently excluded subject possesses an alternative access route, should lead to revision of the access representation.

12.19 Ownership and Control

Ownership is one of the principal architectures through which economic systems organize claims over resources, assets, infrastructures, organizations, and the future uses that may be made of them. Control concerns the effective capacity to shape those uses, access conditions, rules, transfers, or later possibilities. This section de-

velops ownership and control as related but non-equivalent dimensions of economic architecture. Its objective is to distinguish legal ownership, socially organized ownership, possession, use, exclusion, transfer, shared ownership, effective control, and rule-setting while avoiding the assumption that these dimensions necessarily coincide in one actor or institution. The discussion proceeds from legal and social ownership relations through possession, use, exclusion, transfer, and shared ownership, and then examines control without ownership, control over rules and access, and transformation of ownership relations. The method is conceptual and comparative. Institutional, property-rights, organizational, commons, and cooperative traditions are used to identify recurring mechanisms without treating any one legal or economic theory of property as a complete account of ownership in GRE. Table 12.21 summarizes the principal dimensions.

Ownership is often represented as a relation between a person and an object. For economic analysis, a broader relational representation is frequently needed. Ownership claims are constituted through relations among claimants, other subjects, institutions, rules, registries, organizations, enforcement arrangements, and the asset or resource to which the claims refer. The content of ownership can therefore vary across legal systems, organizational forms, asset types, historical periods, and practical settings. A title can be economically consequential because institutions recognize it, because other actors orient their conduct around it, because it supports exclusion or transfer, or because it allocates decision authority. The same formal title can nevertheless generate different practical capacities where enforcement, information, liquidity, contractual conditions, collective governance, technical interfaces, or social recognition differ.

The property-rights literature provides several useful precedents for decomposing ownership. Schlager and Ostrom distinguish positions associated with different bundles of rights rather than treating property as a simple owned/unowned binary (Schlager and Ostrom 1992). In the incomplete-contract tradition, Grossman and Hart model ownership through the allocation of residual control rights when contracts cannot specify every future use of an asset, and Hart and Moore develop this logic further in relation to firm boundaries and control (Grossman and O. D. Hart 1986; O. Hart and J. Moore 1990). These approaches address different analytical problems, but they support a common caution relevant to GRE: an ownership label can conceal several separable relations whose configuration matters for economic capacity and future action.

Definition 12.91 (Ownership architecture). For a specified economic inquiry, an *ownership architecture* is the historically situated configuration of recognized claims, permissions, powers, restrictions, responsibilities, and enforcement relations through which subjects or collectives can possess, use, benefit from, exclude others from, transfer, govern, encumber, or otherwise shape the disposition of an economically consequential entity, resource, or relational position. The relevant dimensions and their holders should be specified rather than inferred from an undifferentiated ownership label.

Definition 12.91 is intentionally broader than a single legal doctrine and narrower than a general theory of property. It provides an analytical vocabulary for identifying which ownership-related relations are economically operative in a given problem. It does not imply that every listed dimension is present, that every dimension is transferable, or that the configuration is normatively justified.

Proposition 12.92 (Ownership–control non-equivalence). *Legal or socially recognized ownership does not by itself establish effective control over every economically relevant use, rule, access condition, or future disposition of an object. Effective control can also arise through contractual position, finance, technical architecture, regulatory authority, organizational role, information advantage, intermediation, dependency, or other relations without corresponding ownership title.*

Proposition 12.92 makes ownership and control separate empirical questions. It also applies in the opposite direction: an owner can hold recognized title while possessing limited practical control because of regulation, debt covenants, fiduciary obligations, collective governance, technical dependence, contractual commitments, shared rights, or weak enforcement. The analytical task is therefore to reconstruct the operative configuration rather than infer power from title alone.

Table 12.21 should be read as an open analytical repertoire. The dimensions can overlap, and the same institutional arrangement can distribute them across several subjects. A cooperative can combine collective ownership with differentiated managerial authority; a trust can separate control from beneficial claims; a lease can allocate use without ownership; a secured lender can influence significant decisions without holding ordinary title; and a digital platform can exercise access and rule-setting control over assets or activities formally owned by others. The relevant architecture is therefore relational and configuration-specific.

Remark 12.93 (Ownership and normative evaluation). GRE does not treat private, public, cooperative, common, shared, or other ownership forms as carrying a fixed normative ranking. Ownership arrangements can generate capacities, security, coordination, stewardship, investment, participation, dependency, exclusion, concentration, conflict, or other consequences under different conditions. Normative evaluation requires specification of the relevant subjects, histories, values, responsibilities, alternatives, and generated relations.

12.19.1 Legal Ownership Relations

Legal ownership relations concern institutionally recognized claims and powers associated with an asset, resource, organization, or other legally cognizable object. Their content depends on the relevant legal order. Title can support use, exclusion, transfer, security interests, inheritance, remedies, or standing in disputes, while also carrying taxes, liabilities, duties, fiduciary restrictions, public-law constraints, or other obligations. Legal ownership is therefore economically significant through the relational consequences attached to the recognized status, rather than through the title word alone.

A legal ownership relation can be represented analytically by identifying at least four elements: the recognized holder or holders; the legally specified object or interest; the incidents or powers attached to the status; and the institutions through which the claim is interpreted, registered, enforced, limited, or contested. This representation is useful because the same physical object can support several legally distinct claims. Land can be subject to leases, easements, mortgages, zoning restrictions, environmental obligations, communal rights, or public access rules. Financial and organizational assets can likewise contain layered claims whose priorities and control consequences differ.

The incomplete-contract literature provides one influential economic representa-

Table 12.21: Selected dimensions of ownership and control.

Dimension	Illustrative economic content	Questions requiring specification
Legal ownership	Recognized title, property status, legal claims, duties, remedies, registrable interests	Jurisdiction, asset definition, title form, enforceability, competing claims, liability, and remedies
Social organization of ownership	Recognized expectations, customary claims, organizational practice, collective understandings	Recognition, legitimacy, enforcement, conflict, institutional support, and relation to formal law
Possession and custody	Physical or operational holding, safekeeping, immediate factual control	Holder, duration, authority, risk, responsibility, revocability, and relation to title
Use rights	Permission or capacity to employ an asset or resource for specified purposes	Scope, duration, conditions, intensity, complementary resources, restrictions, and external effects
Exclusion rights	Capacity to restrict or condition the access or use of others	Object or class of exclusion, authority, procedure, exceptions, enforcement, alternatives, and contestability
Transfer and alienation	Sale, assignment, gift, inheritance, licensing, delegation, encumbrance, or other disposition	Transferable dimension, consent, price, restrictions, reversibility, third-party effects, and residual obligations
Shared or collective ownership	Joint title, cooperative ownership, communal rights, co-ownership, trust-like or layered claims	Membership, voting, benefit rights, contribution, management, exit, conflict resolution, and internal inequality
Effective control	Practical capacity to determine significant uses, decisions, priorities, interfaces, or residual choices	Source of control, scope, duration, dependence, accountability, alternatives, and relation to formal title
Rule-setting and access control	Capacity to define eligibility, interfaces, permissions, standards, procedures, or terms of participation	Rule-making authority, affected subjects, information, review, enforcement, delegation, and exit
Ownership transformation	Reallocation or reconfiguration of claims, powers, restrictions, and control relations	Mechanism, historical sequence, distributional effects, path dependence, residual claims, and institutional adaptation

tion of legal ownership through residual control rights. Grossman and Hart emphasize that where contracts cannot specify every future contingency, ownership can allocate authority over unspecified uses of assets (Grossman and O. D. Hart 1986). Hart and Moore use a related property-rights framework to analyze firm boundaries and more general control structures (O. Hart and J. Moore 1990). GRE treats this as one useful formalization under specified assumptions rather than as a universal definition of ownership. Legal systems can organize property through rights, duties, public constraints, collective claims, beneficial interests, and procedural rules whose economic relevance can extend beyond residual asset control.

Legal ownership also interacts with the access architecture developed in Section 12.18. A title can create access to credit, legal remedies, rental income, decision procedures, or transfer markets, but these capacities can depend on registration, documentation, liquidity, institutional recognition, complementary knowledge, and the willingness of others to transact. Legal ownership is consequently one source of economic capacity whose practical realization remains relational.

12.19.2 Social Organization of Ownership

Ownership is also organized through social recognition, expectations, customary practices, organizational routines, and repeated relations. These social dimensions can support formal law, supplement it, conflict with it, or remain partially independent from it. An economic analysis limited to registered title can therefore miss operative claims that shape who may use a resource, who is expected to maintain it, who receives benefits, who may transfer it, and whose objections are treated as consequential.

Institutional economics provides a useful precedent for treating working rules and collective action as constitutive of economic relations. Commons emphasizes institutions as collective action that structures individual action through working rules (Commons 1931). In a related but distinct domain, Ostrom's research on commons demonstrates that durable resource arrangements can depend on locally developed rules, monitoring, membership, and governance that cannot be reduced to a simple private-versus-state ownership dichotomy (Ostrom 1990; Ostrom 2005). These traditions motivate attention to ownership as socially enacted while leaving the precise legal and normative status of particular claims to the relevant context.

Socially organized ownership can matter where formal rules are ambiguous, incomplete, expensive to invoke, weakly enforced, or mediated through organizations and communities. Repeated recognition can stabilize expectations about control and benefit. Social practice can also disadvantage actors whose claims receive weak recognition despite formal entitlement. The analytical problem is therefore not to replace legal ownership with social convention, but to examine how formal and informal recognitions jointly shape practical ownership capacities.

The social organization of ownership is historically revisable. Migration, technological change, organizational restructuring, legal reform, financialization, environmental change, inheritance, and shifts in community membership can alter which claims are recognized and how conflicts are resolved. GRE therefore treats socially organized ownership as an empirical configuration whose persistence requires explanation.

12.19.3 Possession and Custody

Possession concerns factual holding or immediate control over an object, while custody emphasizes responsibility for keeping, operating, or safeguarding it under some recognized arrangement. These relations can coincide with ownership but frequently do not. A tenant possesses a dwelling without owning it; a warehouse holds goods owned by clients; an employee operates equipment owned by an organization; a custodian can be responsible for an asset while lacking discretion over its transfer or final use.

Possession can generate substantial economic capacity because proximity and immediate control affect timing, monitoring, maintenance, access, and bargaining position. Physical possession of a scarce input can permit production to continue while a distant owner has formal title. Possession can also generate responsibilities and risks, including maintenance, loss, damage, compliance, or return obligations. The economic significance of possession therefore depends on the surrounding legal, contractual, technical, and relational conditions.

A possession claim should specify duration and revocability. Temporary possession under a lease, bailment, employment relation, loan, or emergency arrangement differs from possession backed by an indefinite claim. The possibility of revocation can affect investment, maintenance, planning, and dependency even when current use is uninterrupted. Historical experience of dispossession or unreliable tenure can likewise shape behavior beyond the formal terms of the present arrangement.

Possession is especially useful analytically when ownership data provide a poor approximation of practical control. At the same time, possession should not be treated as sufficient evidence of legitimate ownership, durable access, beneficial entitlement, or rule-setting authority. It is one dimension within the broader ownership architecture.

12.19.4 Use Rights

Use rights concern recognized permissions or practical capacities to employ an asset or resource for specified activities. Their scope can be narrow or broad, continuous or temporary, exclusive or shared. Use can be attached to ownership, membership, contract, public entitlement, customary practice, license, organizational role, or informal permission.

Property-rights analysis of common-pool resources provides a useful vocabulary for separating access and withdrawal or use rights from higher-order management, exclusion, and alienation rights (Schlager and Ostrom 1992). The distinction matters beyond natural resources. Software licenses, leased equipment, shared laboratories, public infrastructure, intellectual-property arrangements, housing, cooperative assets, and organizational facilities can all grant use while reserving ownership or higher-order rule-setting elsewhere.

The economic value of a use right depends on conditions beyond formal permission. Timing, reliability, quality, complementary infrastructure, technical standards, congestion, maintenance, insurance, information, and restrictions on adaptation can determine whether the right supports a meaningful capacity. A right to use equipment only during unsuitable hours or through an incompatible interface can provide substantially less capacity than its formal description suggests.

Use rights can also generate obligations. Users may be required to contribute to maintenance, observe safety rules, preserve a shared resource, report usage, refrain from harmful activities, or return an asset in specified condition. GRE therefore treats use as a relation embedded within a configuration of capacities, constraints, responsibilities, and future effects.

12.19.5 Exclusion Rights

Exclusion rights concern the capacity to determine who may enter, access, use, or benefit from an economically consequential object or relation and under what conditions. Exclusion can support investment, privacy, security, stewardship, congestion management, or coordination. It can also restrict alternatives, produce dependency, or concentrate bargaining power. Its economic role is therefore mechanism- and context-dependent.

Schlager and Ostrom distinguish exclusion from other property rights in their analysis of natural-resource regimes (Schlager and Ostrom 1992). This separation is particularly useful for GRE because control over exclusion can be held by actors who do not possess every other ownership incident. A regulator can determine eligibility for use; a platform can control access to an interface; an association can set membership conditions; a landlord can retain some exclusion powers while granting possession; and a cooperative can distribute exclusion authority through collective procedures.

Exclusion should be specified in terms of object, subject, procedure, and alternatives. A right to exclude one class of users can coexist with obligations to admit another. Exclusion can be conditional on payment, certification, safety, capacity, residency, membership, conduct, technical compatibility, or other criteria. Procedural rights of notice, review, appeal, or contestation can also affect the practical character of exclusion.

Effective exclusion can differ from formal exclusion. A formally exclusive owner can lack the practical means to enforce boundaries, while a non-owner can exercise strong *de facto* exclusion through technical standards, passwords, ranking systems, control of distribution channels, or organizational authority. This again illustrates why ownership and effective control require separate observation.

12.19.6 Transfer and Alienation

Transfer concerns the reallocation of ownership-related claims, permissions, obligations, or control positions between subjects. Alienation refers more specifically to the capacity to dispose of an ownership interest through sale, gift, assignment, inheritance, or other recognized mechanisms. Transferability varies widely across ownership dimensions: possession can be delegated without title; use can be licensed; income rights can be assigned; voting rights can be restricted; and some claims can be non-transferable by design or law.

The ability to transfer can generate liquidity, specialization, reallocation, inheritance, risk sharing, and adaptation. Restrictions on transfer can support continuity, stewardship, collective governance, public purpose, protection of vulnerable parties, or other situated commitments. GRE therefore treats transferability as an architectural variable rather than a presumption that more alienability is necessarily preferable.

Transfer also has a temporal and relational structure. A sale can extinguish some claims while preserving warranties, debt, easements, regulatory duties, environmental liabilities, employment obligations, service commitments, or other residual relations. The economic event is therefore rarely a complete erasure of prior history. Transfer can create a new ownership configuration while leaving parts of the former relational architecture in force.

Nozick's entitlement theory provides a historically influential normative account in which acquisition, transfer, and rectification play central roles (Nozick 1974). GRE does not adopt that theory as its normative foundation. Its relevance here is narrower: ownership analysis often requires historical attention to how a present claim was acquired, transferred, inherited, constrained, or contested. Present title alone may be insufficient when the inquiry concerns legitimacy, responsibility, path dependence, or residual obligation.

12.19.7 Shared and Collective Ownership

Shared and collective ownership distribute ownership-related claims across multiple participants rather than locating them in a single holder. This broad category includes co-ownership, cooperatives, communal arrangements, partnerships, trusts and trust-like structures, employee or consumer ownership, and other architectures in which claims to use, benefit, govern, transfer, or control are distributed.

Collective ownership does not imply equal control. Voting rules, contribution requirements, delegated management, differential shares, expertise, information, agenda authority, and exit conditions can generate substantial internal differentiation. The International Cooperative Alliance, for example, defines cooperatives through joint ownership and democratic control while also specifying principles concerning membership, economic participation, autonomy, cooperation, and community concern (International Cooperative Alliance 1995; International Cooperative Alliance 2017). These principles illustrate one historically developed ownership architecture rather than a universal template for collective ownership.

Trust law provides another example of layered ownership-related relations. Hansmann and Mattei analyze trusts as arrangements that separate control, beneficial interests, and claims against assets in ways that cannot be represented adequately by a simple single-owner model (Hansmann and Mattei 1998). The economic significance of such arrangements lies partly in how different claims are partitioned and protected across parties.

Commons research likewise demonstrates that shared-resource governance can contain differentiated bundles of operational and collective-choice rights (Ostrom 1990; Schlager and Ostrom 1992). Collective ownership should therefore be reconstructed through its actual membership, use, benefit, management, exclusion, transfer, contribution, monitoring, and conflict-resolution relations.

Remark 12.94 (Shared ownership and internal heterogeneity). A shared ownership label should not be used as evidence of equal participation, equal benefit, equal exposure, or equal control. Analysis should identify how the relevant ownership dimensions are distributed internally and how that distribution changes through time.

12.19.8 Effective Control without Ownership

Effective control can arise without formal ownership where a subject or organization possesses practical capacity to determine economically significant uses, decisions, interfaces, or residual choices. Contractual authority, debt relationships, technical architecture, managerial position, information asymmetry, platform intermediation, regulation, procurement dependence, and control of complementary infrastructure can all generate such capacity under some conditions.

The incomplete-contract literature emphasizes residual control as one mechanism connecting ownership to decision authority (Grossman and O. D. Hart 1986; O. Hart and J. Moore 1990). GRE broadens the empirical question by allowing residual or effective control to be distributed across several relations. A nominal owner can depend on a lender for financing, a platform for market access, a supplier for indispensable inputs, a regulator for authorization, a manager for operational knowledge, and a standards body for compatibility. Significant practical control can therefore be dispersed or layered even where title is concentrated.

Control without ownership is especially important in digital and organizational settings. A platform can determine interface conditions, rankings, permitted conduct, or access to users while participants retain ownership of their own assets. An employer can control work processes using leased equipment. A franchisor can shape substantial aspects of independently owned outlets through contractual and technical standards. A financial creditor can constrain investment or asset disposition through covenants. These examples differ institutionally, so the relevant control mechanism should be identified rather than inferred from a generic label.

Proposition 12.95 (Relational sources of effective control). *Effective economic control can be generated by ownership, contractual authority, organizational position, finance, information, technical architecture, institutional rule-setting, intermediation, or dependency, separately or in combination. Control attribution should therefore identify the mechanism through which consequential choices can actually be shaped.*

Proposition 12.95 also implies that control is dimension-specific. A lender can control financing conditions without controlling daily operations; a regulator can constrain permissible activity without determining ordinary production choices; a platform can control access while lacking ownership of participating firms; and a manager can possess operational discretion without the authority to sell major assets. Statements that an actor “controls” an economic object should therefore specify the relevant decision domain.

12.19.9 Rule-Setting and Access Control

Control over rules and access concerns the capacity to define the conditions under which other actors may participate, transact, use resources, enter infrastructures, exercise rights, or challenge decisions. This form of control can be economically consequential even when the rule-setter neither owns the underlying resources nor directly performs the regulated activity.

Rule-setting can occur through legislation, regulation, organizational governance, contracts, standards, technical protocols, platform terms, professional certification, membership procedures, or collective-choice arrangements. Commons’s concept of working rules highlights the importance of rules that structure what participants may, must, or must not do in economic transactions and collective action (Commons 1931). Ostrom’s institutional analysis similarly distinguishes operational action from collective-choice processes through which rules are formed or changed (Ostrom 2005; Schlager and Ostrom 1992).

Access control is closely related to, but analytically distinct from, ownership. A standards body can control compatibility; a regulator can determine licensing; a professional association can influence certification; a platform can govern admission and visibility; a cooperative can collectively determine membership; and a public author-

ity can establish access conditions for publicly owned or privately operated infrastructure. The economic consequences depend on scope, alternatives, enforcement, transparency, review, and the distribution of rule-changing authority.

Rule-setting can also shape future ownership relations. Restrictions on transfer, eligibility, collateral, inheritance, interoperability, or organizational form can affect which actors can acquire or retain claims. Conversely, ownership concentration can shift rule-setting capacity toward owners through governance rights, political influence, technical control, or control of complementary assets. GRE therefore treats rule-setting and ownership as potentially recursive relations.

Remark 12.96 (Control over control). Where one actor can alter the rules governing another actor's access or decision authority, the analysis may need to distinguish first-order control over an economic activity from higher-order control over the conditions under which control itself is allocated, reviewed, or revised.

12.19.10 Transformation of Ownership Relations

Ownership relations transform through law, contract, exchange, inheritance, organizational restructuring, financial arrangements, collective action, technological change, institutional reform, dispossession, restitution, standardization, and changes in social recognition. Transformation can alter one ownership dimension while leaving others comparatively stable. Legal title can remain constant while effective control migrates through debt, platform dependence, management, or technical standards; shared ownership can persist while voting rules change; public ownership can coexist with private operational control; and privatization or collectivization can reconfigure several dimensions at once.

Ownership transformation is therefore better represented as a change in configuration than as a simple switch between fixed categories. The relevant history can include changes in holders, objects, rights, obligations, boundaries, enforcement, access, rule-setting, and control. Some changes are readily reversible; others generate sunk investments, network dependence, institutional learning, legal commitments, or social expectations that make later restoration difficult.

Technological change can alter ownership architecture without directly changing title. Digital rights management can change practical use and transfer; cloud services can relocate operational control; interoperability can reduce dependence on a proprietary interface; automated governance systems can redistribute monitoring and enforcement; and new forms of tokenization or digital representation can create additional layers of claims. The economic significance lies in the changed capacities and relations rather than in technological novelty itself.

Transformation can also leave residual obligations. Former owners can retain warranty, pension, environmental, tax, confidentiality, or other duties. Communities can retain historical claims that remain socially or politically consequential after legal transfer. Organizations can inherit liabilities associated with acquired entities. A complete analysis therefore tracks what changes and what remains relationally active after the ownership event.

Proposition 12.97 (Ownership transformation as relational reconfiguration). *A transformation of ownership can alter economic architecture through changes in claims, use, exclusion, transferability, rule-setting, responsibility, access, or effective control even when the underlying physical asset remains unchanged. The significance*

of the transformation depends on which dimensions change, for whom, under what institutional conditions, and with what effects on later capacities and relations.

Proposition 12.97 places ownership within the generative and historical architecture of GRE. Ownership affects more than current allocation. It can shape investment, maintenance, learning, bargaining position, participation, dependency, transfer possibilities, institutional authority, and the formation of future relations. These consequences remain empirical and context-sensitive. An ownership arrangement that expands one capacity can constrain another, and similar legal forms can generate different trajectories under different institutional and relational conditions.

Remark 12.98 (Revisable ownership representation). An ownership representation is a purpose-relative analytical commitment. Evidence that legal title, possession, use, benefit, exclusion, transfer, rule-setting, or effective control are distributed differently from the initial representation should lead to revision of the ownership architecture used in the analysis.

12.20 Transfer and Circulation

Economic architecture is partly constituted by the movement and reallocation of claims, resources, permissions, obligations, information, possession, and control across subjects and configurations. This section develops *transfer* and *circulation* as relational processes whose economic significance depends on what changes position, through which mechanism, under which conditions, and with what residual relations. Its objective is to distinguish several recurrent transfer forms while avoiding the assumption that observable movement is equivalent to complete alienation, that circulation preserves an unchanged object, or that heterogeneous transferred forms can be reduced to a single conserved scalar. The discussion proceeds through exchange, gift, redistribution, contribution, sharing, lending, inheritance, extraction, cross-scale transfer, and the relational consequences of transfer. The method is conceptual and comparative, drawing on institutional, property-rights, entitlement, commons, and exchange traditions where they clarify the architecture of transfer. Table 12.22 summarizes the principal forms considered here.

Transfer and circulation are related but analytically distinct. A transfer concerns a change in the position of one or more economically consequential relations: ownership can move, possession can be delivered, use can be granted, money can be paid, an obligation can be assigned, information can be disclosed, or decision authority can be delegated. Circulation concerns linked sequences through which transferred objects, claims, obligations, or representations continue to move, return, accumulate, fragment, combine, or change form across a wider relational configuration. A single transfer can therefore occur without substantial circulation, while a circulation process can contain many transfers of different kinds.

Definition 12.99 (Economic transfer). For a specified economic inquiry, an *economic transfer* is a historically situated change in the allocation, possession, access, use, claim, obligation, information, benefit, or control position associated with an economically consequential object or relation. A transfer claim should identify the transferred dimension, the relevant parties or configurations, the mechanism of transfer, its temporal structure, the conditions attached to it, and any residual relations that remain after the event.

Definition 12.100 (Economic circulation). *Economic circulation* is a temporally extended configuration of linked transfers through which economically consequential objects, claims, obligations, resources, representations, or control positions move among subjects, organizations, institutions, scales, or relational domains. Circulation can include transformation, delay, return, accumulation, dissipation, capture, or regeneration and therefore does not imply conservation of an unchanged object or scalar value.

Definitions 12.99 and 12.100 preserve distinctions established in the preceding analysis of ownership and control. Transfer of legal title need not coincide with transfer of possession, use, benefit, exclusion authority, or effective control. Conversely, control can shift through delegation, intermediation, contract, standards, or dependency without a change in formal ownership. The analytical object is therefore the changed relational position rather than a generic notion of “movement.”

Proposition 12.101 (Transfer–circulation non-equivalence). *A transfer event does not by itself establish a circulation process, and a circulation process need not consist of repetitions of one homogeneous transfer form. Circulation is established when linked transfers and their transformations form a temporally extended relational pattern whose organization contributes explanatory content to the economic inquiry.*

Proposition 12.101 matters because the same observed flow can arise through different architectures. A stream of payments can represent market exchange, debt service, redistribution, contribution, remittance, rent, licensing, inheritance, or a mixture of these. Similar aggregate flows can therefore embody different claims, obligations, bargaining positions, histories, and future dependencies. Conversely, one economically coherent circulation process can involve several media and transfer forms as resources and obligations change hands.

Table 12.22 is an open analytical repertoire rather than an exhaustive taxonomy. Several forms can coexist within one event. A household transfer can be simultaneously a contribution, a gift, and part of a longer reciprocal relation. A tax-financed public service can combine contribution, redistribution, institutional access, and cross-scale transfer. A loan can become a transfer of control if collateral, covenants, or refinancing dependence materially change decision authority. Classification should therefore follow the mechanism relevant to the inquiry rather than the surface form of the transaction.

Remark 12.102 (Transfer objects and heterogeneous value). The analysis of transfer architecture does not assume that an invariant scalar “value” travels unchanged between parties. What is transferred can change form, meaning, usability, timing, or relational significance as it moves. Money, time, knowledge, care, access, rights, obligations, reputation, and control can be only partially commensurable or conditionally convertible. Questions of heterogeneous value transmission therefore require analysis of the relevant conversion and relational conditions rather than inference from nominal transfer alone.

12.20.1 Exchange Relations

Exchange relations organize transfers through an understood relation between what one party gives and what another provides, promises, or makes available. The relation can be simultaneous or sequential, monetized or non-monetized, standardized or negotiated, formal or informal. Market exchange is one prominent form, yet ex-

Table 12.22: Selected forms and dimensions of economic transfer and circulation.

Transfer form	Relational organization	Questions requiring specification
Exchange	Reciprocal or contractually linked transfers under specified terms	Objects transferred, equivalence rule, timing, enforcement, information, residual obligations, and bargaining conditions
Gift	Transfer without a fully specified contemporaneous equivalent return	Recognition, expectation, reciprocity, obligation, status, timing, interpretation, and future relation
Redistribution	Collection, pooling, reassignment, or allocation through an organizational or institutional center or rule	Authority, contribution base, eligibility, allocation rule, administrative process, burden, incidence, and temporal horizon
Contribution	Transfer into a collective, organizational, communal, or infrastructural pool	Membership, obligation, voluntariness, benefit relation, governance, accounting, and use of the contributed resource
Sharing	Concurrent or sequential access, use, or benefit without complete alienation by one participant	Boundary, congestion, maintenance, scheduling, exclusion, contribution, responsibility, and continuity
Lending	Temporary transfer of possession, use, liquidity, or purchasing capacity with future return or settlement conditions	Duration, interest or fee, collateral, default, risk, enforcement, refinancing, and dependency
Inheritance	Transfer associated with death, succession, or intergenerational continuity	Legal rule, family or community structure, timing, obligations, taxation, indivisibility, control, and historical accumulation
Extraction	Transfer generated through an asymmetric capacity to appropriate, compel, price, tax, claim, capture, or externalize	Authority, bargaining position, alternatives, consent, incidence, externalized costs, contestability, and persistence
Cross-scale transfer	Movement among differently aggregated levels or configurations	Aggregation, incidence, leakage, mediation, transformation, feedback, scale mismatch, and attribution
Circulation consequence	Relational effects produced by repeated or linked transfers	Capacity, dependency, trust, authority, ownership, concentration, obligations, path dependence, and future action possibilities

change can also occur within organizations, households, communities, professional networks, and institutional arrangements.

An exchange analysis should specify the objects or performances being transferred, the terms linking them, the time structure, the recognized authority to transfer, and the conditions under which the agreement is enforced or revised. A purchase of equipment can transfer title, possession, warranty rights, payment obligations, and

future service claims through one transaction. A labor contract can organize recurrent exchange while simultaneously generating authority, dependency, knowledge, and legal relations. The exchange relation is therefore often one dimension of a thicker relational configuration.

Arrow's discussion of gifts and exchanges is useful because it emphasizes the continuing economic role of trust and other social relations even where exchange is formally organized through contracts or markets (Arrow 1972). GRE draws the narrower analytical lesson that explicit exchange terms do not remove the relational conditions of performance. Information, reputation, trust, enforcement, standards, infrastructure, and future interaction can affect whether a nominal exchange is practically realizable.

Exchange also need not imply equality of bargaining position or equivalence in a broader normative sense. Parties can agree to a transaction while facing different alternatives, information, urgency, institutional protections, or capacities to bear failure. The exchange relation should therefore be described separately from any conclusion about fairness, voluntariness, efficiency, or welfare.

12.20.2 Gift Relations

Gift relations involve transfers whose immediate terms do not specify a contemporaneous equivalent return. This does not imply absence of economic consequence or absence of future expectation. Gifts can create or express recognition, gratitude, obligation, affiliation, status, care, solidarity, patronage, reciprocity, or strategic relation. Their interpretation depends on the history and institutional setting in which the transfer occurs.

A gift can therefore be economically consequential even where accounting records classify it as zero-price transfer. The recipient can gain a resource or capacity; the giver can strengthen a relation, acquire reputation, express membership, or create an expectation of future conduct; third parties can reinterpret status or obligation. Arrow's comparison of gifts and exchanges provides a useful reminder that social relations and trust remain economically significant alongside formal exchange (Arrow 1972).

GRE does not assume that every gift conceals an exchange or that every gift creates a reciprocal obligation. The analytical question is empirical and interpretive: what expectations, meanings, permissions, or future relations become attached to the transfer in the configuration being studied? A gift among close relations, a charitable donation, a diplomatic gift, a platform subsidy, and a strategic corporate concession can have very different relational structures despite sharing the surface feature of transfer without immediate equivalent payment.

The timing of possible return matters. A gift can produce no later return, a diffuse expectation of reciprocity, a symbolic response, or a future material transfer whose timing and form are unspecified. This temporal openness distinguishes many gift relations from tightly specified exchange while preserving the possibility that gifts participate in longer circulation processes.

12.20.3 Redistributive Transfers

Redistributive transfers reorganize resources, claims, burdens, or access through a rule, organization, authority, or collective arrangement that gathers, reallocates, or redirects economically consequential objects among differently situated participants. Taxation and public expenditure are familiar cases, but redistribution can also occur within households, organizations, insurance pools, cooperatives, charitable systems, mutual-aid arrangements, and other institutions.

The analysis should specify the contribution or collection mechanism, the allocation rule, the relevant administrative process, the eligible or affected positions, the timing of transfers, and the incidence of burdens and benefits. Aggregate fiscal flows can conceal substantial differences between statutory liability, economic incidence, administrative access, and realized benefit. Likewise, an organizational budget can redistribute resources among units while altering authority, staffing, information, and future bargaining positions.

Sen's entitlement analysis demonstrates why aggregate availability does not determine command over resources and why legally and institutionally structured transfers can affect effective access (Sen 1981). GRE uses this insight to treat redistribution as more than arithmetic reassignment. A redistributive transfer can change entitlements, expectations, dependency, institutional access, political or organizational relations, and later capacities.

Redistribution carries no fixed normative valence within GRE. A transfer can support insurance, social provision, risk sharing, organizational continuity, or capability formation; it can also create administrative dependency, exclusion through eligibility rules, or burdens whose distribution is contested. Evaluation requires the situated normative and empirical analysis appropriate to the relevant institution and history.

12.20.4 Contribution Relations

Contribution relations transfer resources, labor, knowledge, time, money, or other capacities into a shared, organizational, communal, infrastructural, or institutional configuration. Contributions can be voluntary, contractual, customary, mandatory, reciprocal, status-linked, or embedded in membership. Their economic significance depends on the relation between contribution, governance, use, benefit, and continuing obligation.

A contribution differs analytically from a simple bilateral exchange when the transferred object enters a pool or collective process whose later use is not exhausted by a direct return to the contributor. Membership dues, cooperative capital, tax payments, open-source work, maintenance labor, household provision, insurance premiums, and contributions to shared infrastructure illustrate different architectures. The contributor's later benefit can be direct, indirect, probabilistic, collective, delayed, symbolic, or absent.

Contribution analysis should identify who can require or request contributions, how amounts or forms are determined, whether contribution affects membership or voice, how the pooled resource is governed, and how benefits and burdens are distributed. In commons research, durable arrangements often depend on rules connecting appropriation, contribution, monitoring, and collective governance (Ostrom 1990; Ostrom 2005). GRE treats this as one important family of institutional arrange-

ments without generalizing one commons design to all contribution systems.

Contributions can also generate path dependence. Repeated contribution can build shared infrastructure, organizational memory, trust, or collective capacity. It can equally generate expectations of continued support, unequal burdens, or dependency on a narrow contributor base. The relevant consequence depends on how contribution interacts with governance and access.

12.20.5 Sharing Arrangements

Sharing arrangements distribute access, use, benefit, or responsibility across several participants without requiring complete alienation of the underlying resource by one participant. Sharing can be simultaneous, scheduled, pooled, rotational, conditional, or governed by membership. It can apply to physical assets, infrastructure, knowledge, data, time, facilities, risks, or other economically consequential objects.

Sharing is analytically distinct from open access. A shared resource can have well-defined membership, use limits, scheduling rules, contribution obligations, maintenance duties, monitoring, and exclusion procedures. Ostrom's work on common-pool resources demonstrates the importance of institutional arrangements that organize collective use and governance rather than treating shared resources as unregulated open-access domains (Ostrom 1990). Property-rights analysis likewise distinguishes access and use rights from management, exclusion, and alienation (Schlager and Ostrom 1992).

The economic consequences of sharing depend on divisibility, congestion, compatibility, timing, maintenance, quality, and governance. Sharing an underused durable asset can increase utilization without materially reducing another user's capacity; sharing a congestible resource can generate interference; sharing information can permit simultaneous use while creating privacy, appropriation, or strategic concerns. The transfer architecture therefore varies with the properties of the object and the rules of use.

Sharing can also redistribute responsibility. Participants can acquire duties to maintain, report, replenish, repair, schedule, or preserve access for others. A complete analysis should therefore observe both the benefit relation and the governance burden through which sharing remains viable or becomes contested.

12.20.6 Lending and Temporary Transfer

Lending organizes temporary transfer of possession, use, liquidity, purchasing capacity, or other economic capability under conditions of return, repayment, settlement, or replacement. The transferred dimension should be specified because lending money differs from lending an object, granting temporary access, leasing productive equipment, or advancing inventory. Each architecture distributes control, risk, duration, and residual claims differently.

Credit is a particularly important lending relation because present capacity is linked to future obligation. A loan can expand the borrower's current action set while creating repayment schedules, interest obligations, collateral relations, covenants, information requirements, and possible consequences of default. The lender can gain a claim on future payment without acquiring ordinary ownership of the borrower's

assets, although collateral or contractual provisions can create conditional control rights.

Temporary transfer is therefore inherently temporal. Maturity, recall, renewal, grace periods, refinancing, depreciation, maintenance, and uncertainty about future conditions can affect the practical relation. Two loans of the same principal can create very different dependencies if one is readily refinanced and another matures during a period of weak alternatives. The history of repeated lending can also change reputation, access, bargaining position, and expectations.

Lending should not be reduced to the nominal transfer amount. The relevant configuration includes who bears price, default, liquidity, maintenance, technological, or other risks; who controls adaptation during the lending period; and which residual relations remain after repayment or return. A completed payment can extinguish one obligation while leaving information, reputation, collateral release, warranty, or institutional relations in place.

12.20.7 Inheritance and Intergenerational Transfer

Inheritance and intergenerational transfer relocate ownership claims, resources, obligations, knowledge, status, or control across generations or succession events. These transfers are economically significant because they connect present positions to accumulated histories that predate the current subjects and can influence later access, capacity, dependency, and institutional standing.

Inheritance is institutionally structured. Legal succession rules, wills, trusts, taxation, family forms, organizational constitutions, community practices, creditor claims, indivisibility of assets, and administrative procedures can shape what can be transferred and to whom. Transfer can concern more than wealth in a narrow financial sense. Businesses, land-use rights, professional knowledge, housing access, social networks, debts, care obligations, reputational positions, and organizational responsibilities can all have intergenerational dimensions.

A present ownership position therefore can contain inherited historical structure. Nozick's entitlement theory is one influential example of a normative framework that assigns central importance to acquisition, transfer, and rectification (Nozick 1974). GRE does not adopt this theory as a universal normative foundation. The narrower relevance is analytical: the history through which a holding or obligation was transmitted can matter when the inquiry concerns legitimacy, responsibility, path dependence, cumulative advantage, or unresolved claims.

Intergenerational transfer also demonstrates why circulation need not preserve the same object. A productive enterprise can be inherited as a legal entity while its technology, workforce, relationships, and market position change. Knowledge can be transmitted through education or apprenticeship while being reinterpreted. Land can remain physically located while the rights, uses, environmental conditions, and community relations attached to it change. The relevant continuity is therefore dimension-specific.

12.20.8 Extraction and Asymmetric Transfer

Extraction and asymmetric transfer concern transfer processes in which differences in authority, alternatives, bargaining position, information, ownership, institutional

standing, technical control, or capacity materially shape who can appropriate resources or benefits and who bears corresponding costs or obligations. The term *extraction* is used here analytically rather than as an automatic normative verdict. Its application should identify the mechanism through which asymmetry affects the transfer.

Extraction can occur through several architectures. An owner can claim rent; a creditor can exercise priority; an intermediary can charge access fees; an organization can appropriate a share of collectively produced output; a state can levy taxes; a platform can set commissions; a dominant counterparty can shift risks through contract; or an actor can externalize costs onto parties outside the immediate transaction. These cases differ legally, institutionally, and normatively even when each contains a directional transfer.

The analytical task is therefore to specify authority, alternatives, incidence, consent conditions, rule-setting power, exit possibilities, and the distribution of costs and benefits. A transfer should not be classified as extractive merely because it is unequal in amount. Conversely, formal agreement does not by itself establish symmetric bargaining or absence of coercive dependence. The relevant question is how the relational configuration structures appropriation and burden.

Extraction can also alter the conditions of future transfer. Recurrent appropriation can reduce one party's resources or bargaining alternatives while increasing another's control, thereby making later transfers more asymmetric. Under other conditions, transferred surplus can support infrastructure, coordination, insurance, or capacities from which contributors benefit. A dynamic account should therefore trace what the transfer generates rather than infer its consequences from direction alone.

12.20.9 Cross-Scale Transfer

Cross-scale transfer concerns movement among differently aggregated levels or relational configurations, such as persons, households, organizations, communities, sectors, regions, states, transnational systems, or ecological-economic interfaces. The central analytical problem is that aggregation and disaggregation can change the apparent object, incidence, and meaning of the transfer.

A household can receive income while one member bears unpaid care burdens. A corporation can report a consolidated profit while resources move among subsidiaries. A region can receive investment while gains and costs are unevenly distributed locally. A state can receive tax revenue while collection and expenditure occur through different institutional channels and populations. Cross-scale analysis therefore requires attention to who or what is being aggregated at each stage.

Scale transitions can also transform the transferred object. Local knowledge summarized into organizational indicators loses some contextual information. Individual contributions pooled into an insurance fund become collective risk-bearing capacity. Small payments aggregated through a platform can finance infrastructure or generate market power. National-level statistics can represent flows that do not correspond to transfers experienced by any single subject. The analytical relation between scales is therefore not a simple enlargement of the same object.

Proposition 12.103 (Cross-scale transfer attribution). *Claims about cross-scale transfer should distinguish the level at which a transfer is observed, the level at which costs and benefits are experienced, the mechanisms connecting those levels, and any transfor-*

mations introduced by aggregation, mediation, or institutional processing.

Proposition 12.103 is especially important where aggregate improvement is used to infer distributed benefit or where local loss is used to infer system-level decline. Neither inference is warranted without a mechanism linking the scales. Cross-scale circulation can include leakage, concentration, redistribution, transformation, or feedback that changes the relation between local and aggregate outcomes.

12.20.10 Relational Consequences of Transfer

Transfers do more than change the location of an object. They can modify ownership, access, capacity, obligation, authority, trust, reputation, dependency, expectations, and future bargaining positions. These relational consequences can persist after the transferred resource has been consumed, repaid, returned, or replaced. Transfer history can therefore become part of the economic architecture through which later action is organized.

A transfer can generate new relations. Lending creates repayment obligations; sharing can create maintenance duties; gifts can alter expectations; inheritance can reorganize membership and control; redistribution can create administrative access or classification; contributions can support collective capacity; extraction can reinforce dependency; exchange can establish reputational histories. The economic effect of transfer is consequently partly located in what the transfer makes possible or constrains afterward.

A transfer can also dissolve or weaken relations. Repayment can end a debt relation; sale can terminate some ownership claims; exit can end contribution obligations; redistribution can reduce a dependency on one source of provision; technical interoperability can weaken a gatekeeping relation. Yet dissolution is often partial. Records, warranties, liabilities, reputational effects, environmental consequences, learned expectations, and institutional classifications can remain after the primary transfer is complete.

Proposition 12.104 (Relational consequence of transfer). *Where a transfer changes later capacities, obligations, access conditions, authority, dependency, expectations, or feasible relations, the transfer should be analyzed as a transformation of economic architecture in addition to its immediate movement of resources or claims.*

Proposition 12.104 provides the main link between transfer analysis and the broader generative-relational programme. A transfer is economically consequential not only because something changes hands, but because the event can alter the relational conditions under which subsequent histories unfold. This does not imply that every transfer has large or durable effects. The relevant consequences remain empirical, scale-dependent, and historically situated.

12.21 Labor and Participation

Labor and participation connect economic subjects to processes through which goods, services, care, knowledge, infrastructures, organizational routines, and other capacities are produced, maintained, transformed, or reproduced. This section develops labor as an economic activity, relation, and contribution while keeping employment, remuneration, participation, and contribution analytically distinct. Its objective is to

provide a sufficiently broad architecture for examining paid and unpaid labor, care and reproductive activity, knowledge-intensive work, automated and artificial participation, and forms of economic participation that extend beyond employment. The discussion is conceptual and comparative. It draws selectively on political economy, feminist economics, human-capital and knowledge traditions, labor-managed-firm analysis, and recent work on automation and algorithmic work where these literatures clarify particular dimensions. Table 12.23 summarizes the principal distinctions.

Labor is economically significant in more than one way. It can refer to activity performed, to a relation through which activity is organized, to a contribution to a collective process, or to a recognized category through which income, rights, obligations, status, and institutional protection are assigned. These dimensions often overlap, yet they need not coincide. Employment is one important institutional form of labor relation, but unpaid household work, care, voluntary contribution, cooperative participation, informal work, self-employment, and machine-mediated production demonstrate that economic participation exceeds standard employment categories. Classical political economy already treated labor and the division of labor as central to production and productive capacity (Smith 1776; Marx 1867). Feminist economics later made especially visible the economic importance of unpaid household and care activity that conventional accounting and labor categories can obscure (Waring 1988; Himmelweit 1995; Power 2004).

Definition 12.105 (Economic labor). For a specified economic inquiry, *economic labor* is purposive activity whose performance contributes to the production, maintenance, reproduction, transformation, coordination, or availability of economically consequential goods, services, capacities, relations, organizations, institutions, or infrastructures. A labor attribution should specify the activity, its organizational and relational conditions, the relevant time horizon, the form of recognition or compensation where present, and the mechanism through which the activity contributes to the economic process under study.

Definition 12.106 (Economic participation). *Economic participation* is a historically situated relation through which a subject, group, organization, or other relevant participant contributes to, is represented in, influences, depends on, or is affected by an economic process or configuration. Participation can occur through labor, ownership, governance, consumption, contribution, care, knowledge production, institutional membership, platform activity, community practice, or other mechanisms. Participation therefore does not imply employment, equal influence, equal benefit, or normative desirability.

Definitions 12.105 and 12.106 separate labor from the wider category of participation. A person can participate economically without performing labor in the narrow sense, for example through ownership, governance, consumption, investment, institutional membership, or receipt of care. Conversely, labor can be economically consequential even where it is weakly recognized, unpaid, informally organized, or excluded from conventional employment statistics. The analytical task is to identify the relation through which activity and participation matter rather than infer significance from one administrative category.

Proposition 12.107 (Labor–employment non-equivalence). *Employment status is neither a necessary nor a sufficient representation of economically consequential labor. Labor analysis should distinguish the activity performed, the relation organizing that*

activity, the form of compensation or recognition, and the capacities or obligations generated through the activity.

Proposition 12.107 does not dissolve the importance of employment. Employment contracts can organize remuneration, authority, scheduling, protection, benefits, training, responsibility, and bargaining rights in consequential ways. The proposition instead prevents the employment category from becoming a proxy for the full field of labor and participation.

Table 12.23 should be read as an open analytical repertoire. The dimensions can overlap and additional forms may become relevant in particular domains. A care worker can be simultaneously an employee, household member, knowledge holder, institutional participant, and relational support provider. A software engineer can perform paid knowledge-intensive labor while also training colleagues and maintaining infrastructural knowledge that is only partly captured by measured output. A machine-learning system can perform selected tasks while depending on human design, data, maintenance, governance, and institutional responsibility. Classification should follow the mechanism relevant to the inquiry.

12.21.1 Labor as Economic Activity

Labor as economic activity concerns what is done: producing, maintaining, repairing, coordinating, caring, transporting, teaching, designing, interpreting, monitoring, cleaning, coding, administering, or otherwise contributing to an economically consequential process. Activity-level analysis is useful because the same institutional category can contain heterogeneous tasks, and similar tasks can be performed under different legal, organizational, and social relations.

Task decomposition can clarify technological substitution and complementarity. Recent automation research, for example, distinguishes the displacement of tasks from the creation of new tasks and thereby shows why technological change can reorganize labor demand without mapping neatly onto whole occupations (Acemoglu and Restrepo 2019). GRE can use such task-level distinctions where they improve empirical analysis while retaining the broader historical and relational setting in which tasks are allocated, recognized, and governed.

Activity also has temporal and embodied dimensions. Two activities that appear similar in an output measure can differ in scheduling constraints, fatigue, emotional demand, exposure to risk, need for tacit judgment, or dependence on complementary resources. Labor analysis should therefore avoid inferring the full economic significance of activity from output quantity alone. Where the inquiry concerns capabilities, health, learning, care, or relational continuity, these conditions can be constitutive of the economic process rather than secondary details.

12.21.2 Labor Relations

Labor relations concern the relational architecture through which activity is organized. They can include wage contracts, self-employment, household obligations, apprenticeships, cooperative membership, platform-mediated work, professional norms, public-service roles, reciprocal community arrangements, or other forms. A labor relation can specify who has authority to assign tasks, who bears risk, how

Table 12.23: Selected dimensions of labor and economic participation.

Dimension	Economic significance	Questions requiring specification
Activity	Performance of tasks, care, production, maintenance, coordination, learning, or reproduction	What is done, with what resources, under what conditions, over what time, and with what effects?
Labor relation	Organization of activity through contract, authority, reciprocity, household relation, cooperative governance, platform mediation, or other arrangements	Who sets tasks, schedules, standards, remuneration, monitoring, responsibility, and revision?
Contribution	Addition to a collective, organizational, infrastructural, epistemic, or productive process	What contribution is attributable, how is it recognized, and how are benefits and burdens distributed?
Compensation and recognition	Wage, salary, fee, share, in-kind provision, entitlement, status, or absence of explicit compensation	Which contributions receive payment or recognition, through what rules, and with what exclusions?
Care and reproduction	Maintenance and reproduction of persons, households, communities, and capabilities	Who performs care, who receives it, how are time and dependency organized, and which effects remain outside market accounting?
Knowledge-intensive work	Creation, interpretation, transmission, and application of knowledge	Where does knowledge reside, how is it shared or protected, and how are learning and tacit expertise organized?
Automated participation	Machine-performed tasks, algorithmic mediation, and AI-assisted production or coordination	Which functions are automated, who designs and controls the system, where does responsibility remain, and what complementary human activity is required?
Participation beyond employment	Governance, volunteering, commons contribution, household provision, consumption, community work, ownership, or institutional participation	What form of participation occurs and what capacities, obligations, recognition, or influence follow from it?
Differentiated participation	Uneven access to roles, voice, compensation, learning, ownership, decision power, or exit	Which dimensions differ across participants, through what mechanisms, and with what cumulative consequences?
Generative consequence	Later capacities, relations, knowledge, dependencies, identities, institutions, or possibilities produced through participation	What does participation generate over time, for whom, at what scale, and under what historical conditions?

compensation is determined, how performance is monitored, what protections apply, and how disagreement or exit is handled.

Classical analysis of the labor process already emphasized that production re-

lations concern more than the physical performance of work; they also organize control, cooperation, division of labor, machinery, and appropriation (Marx 1867). Contemporary algorithmic-management research similarly shows that computational systems can participate in directing, evaluating, and disciplining work, altering how authority is exercised even when the formal employment relation remains unchanged (Kellogg et al. 2020). These literatures differ substantially in theoretical orientation, but both illustrate the analytical importance of the relation that organizes activity.

The labor relation can therefore change while the task remains similar. A driver can perform transport activity as an employee, contractor, platform participant, cooperative member, or owner-operator. The surface activity may be comparable, yet authority, income risk, asset ownership, scheduling, insurance, data access, dispute resolution, and exit conditions can differ materially. GRE should reconstruct these dimensions rather than infer the relation from the task label.

12.21.3 Labor and Contribution

Contribution concerns the relation between activity and a wider process or capacity. Labor can contribute to immediate output, maintenance of infrastructure, reproduction of capabilities, organizational memory, learning, trust, institutional continuity, or future option sets. Contribution therefore extends beyond the marginal addition to a measurable product, although quantitative productivity measures can remain useful for particular questions.

The distinction matters because contribution can be distributed and temporally delayed. A mentor's work can improve another participant's later capacity. Maintenance activity can prevent failure without producing a visible new output. Documentation can preserve organizational memory. Care can enable another person's participation in education or employment. Training can change the future distribution of knowledge. The contribution of labor may therefore be mediated through later relations and events rather than exhausted by contemporaneous output.

Contribution and labor are also non-equivalent. Some contributions do not require labor in the relevant sense, such as provision of capital, ownership rights, access to infrastructure, or institutional authorization. Conversely, labor can be performed without producing the contribution anticipated by the organization or worker. An analysis should therefore specify the mechanism connecting activity to the process whose outcome is being attributed.

Proposition 12.108 (Labor–contribution distinction). *A claim that labor contributes to an economic outcome should identify the mechanism, temporal horizon, and relational pathway connecting the activity to that outcome. Labor performed and contribution realized can diverge because of coordination failure, complementary-resource constraints, institutional conditions, delayed effects, or transformation of the surrounding configuration.*

12.21.4 Paid and Unpaid Labor

Payment is an important economic relation, yet it is not a complete criterion for labor significance. Paid labor is organized through monetary or monetizable compensation under a wide range of contractual and institutional forms. Unpaid labor can occur in

households, care relations, communities, cooperatives, voluntary organizations, family enterprises, internships, open-source projects, and other settings. Some activities combine paid and unpaid components or move between them over time.

Feminist economics has shown that national accounting and conventional work categories can exclude or obscure economically consequential unpaid household and care activity (Waring 1988). Himmelweit's analysis also cautions that expanding the category of work to unpaid domestic activity requires conceptual care because the language of work carries assumptions derived from wage labor (Himmelweit 1995). Social-provisioning approaches accordingly analyze paid and unpaid activity together with well-being, care, power, and institutional conditions (Power 2004).

GRE can draw on this tradition without treating every useful or meaningful activity as labor. The analytical question is whether a specified activity contributes to an economic process in a way relevant to the inquiry and how its recognition, compensation, obligation, and distribution are organized. Absence of payment can conceal contribution; presence of payment does not by itself establish social usefulness, fair recognition, or desirable relational conditions.

12.21.5 Care Labor and Reproductive Activity

Care labor and reproductive activity concern the maintenance and reproduction of persons, relationships, households, communities, and capabilities across time. They can include feeding, cleaning, emotional support, health-related assistance, childrearing, elder care, coordination of household life, and other activities through which everyday participation becomes possible. These activities can be paid, unpaid, familial, communal, professional, institutional, or distributed across several arrangements.

Care is economically significant partly because it changes capacities and dependencies. A person's ability to learn, work, recover, travel, or participate can depend on care provided by others. Care arrangements can therefore redistribute time, opportunity, risk, and bargaining position among household or community members. The earlier analysis of households and provisioning is relevant here: care cannot be reconstructed adequately by observing only household-level income or aggregate consumption.

Care relations also contain normative and experiential dimensions that economic measurement may only partly represent. GRE should therefore avoid reducing care to a homogeneous service unit merely because some components can be priced. At the same time, interpretive richness should not become a reason to exclude operational analysis where it is useful. Time-use measures, staffing ratios, access indicators, labor conditions, and outcome measures can contribute to inquiry while remaining partial representations of the care relation.

12.21.6 Knowledge-Intensive Labor

Knowledge-intensive labor depends substantially on the creation, interpretation, recombination, communication, or application of knowledge. Examples include research, design, teaching, diagnosis, software development, legal analysis, engineering, scientific work, management, and many forms of professional or technical practice. The category remains purpose-relative because most labor contains some

knowledge component and because the boundary between routine and knowledge-intensive tasks changes with technology and organization.

Human-capital analysis provides one influential representation of acquired knowledge and skill as productive capacity (Becker 1964). Hayek's analysis of dispersed knowledge provides a different emphasis, drawing attention to the fact that economically relevant knowledge can be distributed across participants and may not be available to any single coordinating center (Hayek 1945). GRE can use both insights while keeping knowledge embedded in relational and institutional conditions: knowledge can be embodied, tacit, codified, distributed, protected, forgotten, or dependent on access to tools and communities.

Knowledge-intensive labor often generates effects beyond the immediate task. Documentation can become organizational memory; mentoring can redistribute expertise; research can create new problem framings; standards can coordinate later activity; software can become infrastructure. These effects can be difficult to attribute to individual workers because they emerge through collaborative, cumulative, or institutional processes. Contribution analysis should therefore preserve both individual activity and the relational configuration through which knowledge becomes usable.

12.21.7 Artificial Participation and Automated Work

Automated systems and artificial agents can perform tasks that participate in economic production, coordination, communication, classification, monitoring, or decision support. This participation can alter the allocation of human tasks, the organization of authority, the distribution of knowledge, and the capacities available to organizations or households. The present subsection treats artificial participation functionally and economically. It does not infer consciousness, moral status, legal personality, or independent responsibility from task performance.

Automation can substitute for selected human tasks while also creating complementary tasks, changing skill requirements, or reorganizing production (Acemoglu and Restrepo 2019). Evidence from generative-AI deployment also indicates that AI assistance can affect productivity and the distribution of performance across workers under particular task and organizational conditions (Brynjolfsson et al. 2025). These findings motivate analysis of task composition and organizational context rather than a categorical claim that AI simply replaces or augments labor in one uniform direction.

Artificial participation should therefore be decomposed into the functions actually performed: generating text or code, ranking options, controlling machinery, matching participants, detecting patterns, maintaining schedules, monitoring performance, or mediating access. The analysis should also identify the human and institutional relations required for those functions, including data production, system design, maintenance, supervision, legal responsibility, energy and infrastructure, and organizational adoption.

Caution 12.109 (Artificial participation and subject equivalence). Functional participation in an economic process does not establish equivalence between artificial systems and human participants with respect to experience, welfare, responsibility, rights, vulnerability, or moral standing. These dimensions require separate argument and evidence. The economic analysis should specify the functional relation under study without importing broader conclusions from task performance alone.

The distributional and political-economic consequences of advanced AI require fuller treatment than this architectural section can provide. Here the relevant point is narrower: artificial systems can become components of labor and participation architectures, and their effects depend on ownership, access, complementary human capacities, organizational design, institutional rules, and the relations through which outputs are interpreted and acted upon.

12.21.8 Economic Participation beyond Employment

Economic participation extends beyond employment because subjects can contribute to and be affected by economic configurations through governance, ownership, consumption, household provision, commons management, volunteering, community activity, professional associations, platform participation, investment, taxation, public deliberation, or institutional membership. These forms differ in their relation to labor, compensation, authority, and responsibility.

Worker participation in enterprise governance provides one established example. Labor-managed-firm theory examines arrangements in which workers participate in enterprise decision-making and income distribution through institutional forms different from conventional capital-managed firms (Vanek 1970). Commons governance and cooperative institutions provide additional examples in which contribution, membership, ownership, and decision authority can be distributed through rules that do not map directly onto employment status.

Participation can also be indirect. Consumers can influence demand without governing production. Citizens can shape public economic institutions through political processes. Community members can sustain shared infrastructure through norms or voluntary contribution. Owners can exercise governance without performing operational labor. The analytical category of participation should therefore be specified by mechanism: contribution, voice, ownership, use, governance, exposure, obligation, or another relation.

12.21.9 Differentiated Participation

Economic participation is commonly differentiated across subjects and positions. Participants can differ in access to roles, compensation, information, learning, ownership, decision authority, representation, recognition, protection, bargaining power, mobility, and exit. A shared label such as employee, member, contributor, or user can therefore conceal materially different participation conditions.

Differentiation can arise through credentials, institutional categories, legal status, organizational hierarchy, network position, care responsibilities, disability, geography, language, technology, wealth, social recognition, or historically accumulated advantage. Some of these differences may be relevant to the functioning of the activity; others can reflect inherited barriers or power relations. GRE should identify the mechanism before interpreting the difference normatively.

Epistemic participation is one important dimension. Whose observations are treated as credible, whose categories become institutionalized, and whose experiential knowledge receives uptake can affect organizational and economic decisions. Work on epistemic injustice provides one relevant vocabulary for credibility and interpretive exclusion (Fricker 2007). The present analysis uses this literature selec-

tively to show that participation can vary in epistemic influence even when formal membership is equal.

Proposition 12.110 (Participation-dimension non-equivalence). *Equality or inclusion in one participation dimension does not establish equality or inclusion in others. Analysis should specify the relevant dimensions of participation and the mechanisms connecting them before drawing conclusions about overall participation or exclusion.*

12.21.10 Generative Consequences of Participation

Participation can alter the capacities, relations, identities, knowledge, institutions, expectations, and future options of both participants and the wider configuration. These effects constitute the generative dimension of labor and participation. They can arise through learning, repeated cooperation, conflict, recognition, reputation, skill formation, organizational memory, institutional reform, network formation, technological adoption, or changes in ownership and authority.

Participation can generate capacities. Workers can acquire skills; communities can develop governance routines; organizations can accumulate knowledge; repeated collaboration can establish trust; participation in decision-making can improve understanding of institutional processes. Generative-justice scholarship provides one existing example of a framework that emphasizes the participation of value generators in the circulation and governance of generated value (Egash 2016). GRE does not treat this or any other participation principle as universally required. Its relevance depends on the specific normative and institutional problem.

Participation can also generate dependency, exhaustion, exclusion, hierarchy, or narrowed alternatives. A worker can accumulate organization-specific skills that increase productivity while reducing outside mobility. A platform participant can gain market access while becoming dependent on ranking or interface rules. A caregiver can sustain household capabilities while losing time for independent income or education. A volunteer community can generate common infrastructure while concentrating invisible burdens on a small number of contributors. Generativity therefore remains analytically separate from desirability.

Proposition 12.111 (Generative consequence of participation). *Where participation changes later capacities, relations, knowledge, institutional positions, dependencies, recognition, or feasible actions, those changes form part of the economic consequence of participation in addition to contemporaneous output or compensation.*

Proposition 12.111 connects labor and participation to the wider GRE programme without turning participation into a universal normative ideal. The appropriate form, depth, and distribution of participation remain historically situated questions. Some processes can require broad participation; others can legitimately rely on specialized authority, automation, representation, or temporary delegation. The analytical responsibility is to make the participation architecture visible and to trace what it generates over time.

Remark 12.112 (Revisable labor and participation categories). The categories developed in this section are provisional analytical resources. Technological change, household transformation, institutional reform, new organizational forms, and changing understandings of care, knowledge, responsibility, and artificial agency can alter what counts as labor or economically significant participation. GRE should therefore permit the categories themselves to be revised when the empirical field or

the purpose of inquiry changes.

12.22 Coordination and Dependence

Coordination and dependence describe two related dimensions of economic architecture. Coordination concerns the processes through which interdependent activities, expectations, resources, decisions, and timings become sufficiently compatible for an economic process to proceed. Dependence concerns the extent to which a subject or configuration relies on resources, capacities, knowledge, infrastructure, permissions, or actions that are located partly outside its immediate control. This section develops these dimensions together because coordination arrangements often redistribute dependence, while dependence conditions the feasible forms of coordination. Its objective is to provide a comparative vocabulary for hierarchical, market, network, cooperative, and algorithmic coordination and for resource, capability, and epistemic dependence. The discussion is conceptual and comparative, drawing selectively on organizational economics, network analysis, institutional research, collective-action scholarship, resource-dependence theory, and studies of algorithmic control. Table 12.24 summarizes the principal dimensions.

Coordination is broader than centralized direction. Prices, contracts, routines, standards, norms, interfaces, reciprocity, deliberation, professional conventions, infrastructures, and algorithmic systems can each contribute to the alignment of interdependent activity. Classical work on the firm emphasized that economic coordination can occur through organizational authority as well as through the price mechanism (Coase 1937; Williamson 2000). Work on distributed knowledge emphasized the coordinative role of prices where relevant knowledge is dispersed (Hayek 1945). Network and institutional research further demonstrates forms of coordination organized through recurrent relations, reciprocity, trust, collaboration, and shared rules that cannot be represented adequately by a simple market–hierarchy dichotomy (Powell 1990; Granovetter 1985; Ostrom 1990).

Definition 12.113 (Economic coordination). For a specified economic process, *economic coordination* is the historically situated organization of interdependent activities, decisions, expectations, resources, or timings such that participants or components can achieve a degree of mutual compatibility relevant to that process. A coordination analysis should specify what is being coordinated, through which mechanisms, among which positions, over what horizon, and with what consequences for capacity, burden, dependence, and revision.

Definition 12.114 (Economic dependence). For a specified subject or configuration, *economic dependence* is a relation in which the maintenance or exercise of a relevant capacity depends materially on resources, actions, knowledge, infrastructures, permissions, recognition, or complementary capacities controlled, supplied, mediated, or sustained elsewhere. Dependence is therefore relative to the capacity, time horizon, available alternatives, and relational position under examination.

Definitions 12.113 and 12.114 keep coordination and dependence analytically separate. A market transaction can coordinate exchange while leaving participants relatively substitutable. A tightly integrated production process can coordinate effectively while creating strong mutual dependence among specialized participants. A household can depend on public infrastructure without that infrastructure actively

coordinating household decisions. The relevant analytical task is therefore to identify both the coordination mechanism and the dependence structure where each matters.

Proposition 12.115 (Coordination–dependence non-equivalence). *The presence, intensity, or effectiveness of coordination does not by itself determine the presence, direction, or asymmetry of dependence. Coordination and dependence should be specified through their own mechanisms before conclusions are drawn about resilience, autonomy, power, efficiency, or normative desirability.*

Table 12.24 is an open analytical repertoire rather than a complete taxonomy. Real configurations commonly combine several forms. A platform can coordinate market exchange through prices while using algorithms to rank participants and organizational authority to set platform rules. A hospital can combine professional hierarchy, team coordination, market procurement, public regulation, and dependence on specialized infrastructures. A commons can coordinate through collective rules while remaining dependent on external legal recognition, financing, or ecological conditions. The appropriate decomposition therefore follows the mechanisms relevant to the inquiry.

12.22.1 Hierarchical Coordination

Hierarchical coordination organizes interdependent activity through differentiated roles, authority, reporting relations, internal rules, planning routines, and procedures for allocating tasks and resources. Its analytical significance arises where some decisions are coordinated within an organization or authority structure rather than renegotiated through separate market transactions. Coase's analysis of the firm identified the costs of using the price mechanism as one reason economic activity can be organized through firms, while later institutional economics developed governance structures as an important object of comparative analysis (Coase 1937; Williamson 2000).

Hierarchy can reduce some coordination burdens by establishing recognized decision rights, shared routines, common records, and procedures for resolving conflicts. It can also create informational distance, bottlenecks, dependence on superior positions, and reduced local discretion. These consequences vary with the depth of hierarchy, delegation arrangements, expertise distribution, communication channels, and the reversibility of decisions.

Hierarchical coordination should therefore be reconstructed through actual decision relations rather than inferred from an organizational chart alone. Formal authority can be weakly exercised, informally redistributed, technically constrained, or dependent on specialized subordinates. Conversely, actors without senior formal titles can exercise consequential coordination through expertise, control of infrastructure, agenda-setting, or procedural knowledge. The relevant object is the enacted architecture of coordination.

Remark 12.116 (Hierarchy as a coordination form). Hierarchical coordination is one possible response to interdependence. Its presence does not establish superiority over market, network, cooperative, or hybrid forms, and its absence does not imply decentralized autonomy. Comparative evaluation requires specification of the task, uncertainty, knowledge distribution, transaction conditions, accountability structure, and historical setting.

Table 12.24: Selected dimensions of coordination and dependence in economic architecture.

Dimension	Principal coordination or dependence mechanism	Questions requiring specification
Hierarchical coordination	Authority, roles, routines, reporting, planning, supervision, and internal allocation	Who can direct whom, through which roles and procedures, with what discretion and revision?
Market coordination	Prices, bids, contracts, substitution, exchange opportunities, and expectations	Which information is represented, which conditions remain outside prices, and who can effectively participate?
Network coordination	Recurrent ties, reputation, reciprocity, brokerage, standards, and distributed communication	Which relations carry coordination, how stable are they, and where are bottlenecks or dependencies located?
Cooperative coordination	Shared rules, mutual monitoring, deliberation, contribution, reciprocity, and collective governance	How are common tasks, obligations, disputes, benefits, and revisions organized among participants?
Algorithmic coordination	Ranking, matching, scheduling, recommendation, automated allocation, monitoring, and rule execution	Which objectives and data are encoded, who can revise the system, and how do outputs alter later behavior?
Resource dependence	Reliance on consequential material, financial, infrastructural, institutional, or relational resources	How substitutable is the resource, who controls access, and what happens under interruption?
Capability dependence	Reliance on complementary capacities held by other subjects, organizations, institutions, or infrastructures	Which activity becomes infeasible or degraded when the complementary capacity is absent?
Epistemic dependence	Reliance on knowledge, interpretation, classification, expertise, data, or credibility supplied elsewhere	Which judgments depend on whom, how can claims be checked, and where can epistemic bottlenecks arise?
Dependence asymmetry	Reciprocal reliance with different alternatives, switching costs, control positions, or temporal exposure	How are dependence and alternatives distributed across participants and over time?
Dependence transformation	Diversification, substitution, integration, standardization, portability, learning, mutualization, or institutional change	Which dependence is reduced, relocated, deepened, or newly created by the transformation?

12.22.2 Market Coordination

Market coordination organizes activity through exchange opportunities, prices, bids, contracts, expectations, substitution, and the responses of participants to changing relative conditions. Hayek’s account of dispersed knowledge emphasized the capacity of price movements to communicate selected information relevant to decentralized

adjustment when knowledge is distributed across many actors (Hayek 1945). Within GRE, this insight is retained as one important coordination mechanism while the surrounding institutional and relational conditions remain visible.

Prices can coordinate without representing the entire economic field. They may communicate scarcity, demand, or opportunity under specified market institutions while leaving unrepresented such factors as unpaid care, externalized costs, unequal access, bargaining constraints, legal entitlements, ecological conditions, or distributional consequences. Section-level analysis should therefore ask what the price mechanism coordinates effectively, which participants can respond, and which relevant relations remain outside the represented signal.

Market coordination also depends on infrastructures that make exchange possible: property and contract rules, payment systems, standards, information channels, logistics, dispute resolution, and expectations about future conduct. These conditions can themselves be organized through hierarchical, network, cooperative, or public mechanisms. Market coordination is therefore relationally embedded rather than analytically self-sufficient (Granovetter 1985).

12.22.3 Network Coordination

Network coordination operates through recurrent relations among actors or organizations whose activities are connected without being integrated into one hierarchy or reduced to isolated market transactions. Reciprocal communication, reputation, trust, repeated exchange, joint problem-solving, and relational continuity can coordinate activity across organizational boundaries. Powell's analysis of network forms highlights arrangements in which reciprocal communication and relational exchange differ from both market and hierarchical governance (Powell 1990).

Network coordination can be especially important where knowledge is distributed, tasks are complementary, adaptation is frequent, or collaboration depends on relation-specific learning. Interorganizational innovation research provides one example in which learning and collaboration occur through networks spanning organizational boundaries (Powell et al. 1996). Network position can consequently affect access to information, partners, resources, and future coordination opportunities.

The same architecture can create dependence. A focal actor can rely heavily on a broker, standard-setter, dominant supplier, trusted partner, or dense cluster of specialized relations. Network redundancy can reduce some vulnerabilities, while relation-specific learning can increase switching costs. Network coordination should therefore be analyzed together with topology, alternatives, multiplex relations, and the distribution of brokerage or gatekeeping positions.

12.22.4 Cooperative Coordination

Cooperative coordination organizes interdependent activity through shared rules, reciprocal contribution, deliberation, mutual monitoring, collective governance, or other arrangements in which participants contribute directly to coordination rather than relying exclusively on market exchange or centralized command. Commons research demonstrates that groups can develop durable rule systems for managing shared resources under some conditions, while also documenting failures and considerable institutional diversity (Ostrom 1990; Ostrom 2005).

Cooperative coordination can include member-owned organizations, peer production, commons governance, professional communities, mutual-aid arrangements, and collaborative projects. Large-scale peer production provides one example in which distributed contributors can coordinate through modular tasks, shared technical infrastructures, and community governance without reproducing a conventional firm structure (Benkler 2002). These arrangements vary greatly in membership, authority, contribution rules, sanctioning, representation, and ownership.

Cooperation does not imply equality, consensus, or absence of conflict. Cooperative arrangements can contain differentiated expertise, unequal contribution, informal hierarchy, exclusion, concentrated agenda-setting, or dependency on external infrastructure. Their analysis should therefore specify the actual governance and contribution relations rather than infer normative qualities from the cooperative label.

12.22.5 Algorithmic Coordination

Algorithmic coordination uses computational systems to mediate, sequence, rank, match, allocate, recommend, schedule, monitor, or otherwise structure interdependent activity. Such systems can operate within firms, markets, platforms, public institutions, logistics networks, households, or mixed configurations. Algorithmic coordination is therefore a mechanism that can be embedded in several broader coordination forms rather than a mutually exclusive alternative to hierarchy, markets, or networks.

Algorithmic systems can make coordination rapid and scalable where decisions depend on large volumes of data or repeated allocation. They can also encode objectives, classifications, constraints, and priority rules that are difficult for participants to observe or contest. Research on algorithms at work shows that computational systems can become mechanisms of direction, evaluation, and discipline within organizational relations (Kellogg et al. 2020). Platform research likewise illustrates how matching and pricing systems can coordinate participation across multiple sides (Rochet and Tirole 2003).

GRE should therefore distinguish the computational procedure from the institutional architecture within which it operates. Relevant questions include who selects objectives, which data enter the system, what uncertainty is represented, who can inspect or revise the rules, how exceptions are handled, where responsibility remains, and whether participants possess meaningful alternatives. An algorithmic output can also become a performative input to later behavior when rankings, recommendations, or forecasts alter the field on which subsequent calculations depend.

Caution 12.117 (Algorithmic coordination and closure). Operational consistency or predictive performance does not establish that an algorithmic coordination system captures every economically relevant relation. The system can coordinate effectively with respect to selected objectives while leaving unrepresented burdens, values, external effects, informal knowledge, or distributional consequences. Its analytical assessment should therefore include both encoded and omitted dimensions where they materially affect the inquiry.

12.22.6 Resource Dependence

Resource dependence arises when a relevant capacity relies on access to material, financial, infrastructural, institutional, informational, or relational resources controlled or mediated elsewhere. Resource-dependence theory made this relation central to organizational analysis by emphasizing organizations' dependence on external environments for consequential resources and the strategies through which organizations respond to external constraint and uncertainty (Pfeffer and Salancik 1978).

Within GRE, resource dependence is defined relative to a specified capacity. Dependence on electricity, credit, specialized components, land, legal authorization, computing infrastructure, transport, data, reputation, or trusted partners becomes analytically important when interruption or alteration materially changes what the subject or configuration can do. The same resource can be critical for one process and substitutable for another.

Resource dependence is therefore sensitive to alternatives, switching costs, redundancy, timing, concentration of supply, contractual arrangements, inventories, portability, and the capacity to reorganize production. A subject can possess large nominal resources while remaining strongly dependent on one complementary resource that cannot be replaced within the relevant horizon. Resource abundance and low dependence are consequently distinct properties.

Proposition 12.118 (Capacity-relative resource dependence). *Resource dependence should be attributed relative to a specified capacity, resource relation, time horizon, and set of feasible alternatives. The quantity or value of the resource alone is insufficient to determine the degree or direction of dependence.*

12.22.7 Capability Dependence

Capability dependence concerns reliance on complementary abilities that reside in other subjects, organizations, institutions, infrastructures, or coordinated configurations. A hospital may possess buildings and equipment while depending on specialist clinical capacity. A manufacturer may own machinery while depending on external design expertise, maintenance capability, certification, or logistics. A household can possess financial resources while depending on care, language, mobility, or institutional-navigation capacities held by others.

This distinction extends the resource–capacity non-equivalence developed earlier in the chapter. Resources become effective through conversion and complementary capacities. Capability-oriented economic analysis similarly emphasizes that resources and commodities do not map mechanically onto what persons are effectively able to do or be (Sen 1985; Sen 1999). GRE uses the distinction here descriptively: the object is the relational location of a capacity required for a specified process.

Capability dependence can be mutual. Specialized participants can each possess capacities that become productive only through combination. Mutual complementarity can support cooperation and specialization while also increasing vulnerability to disruption. The relevant inquiry should therefore identify both the capacity generated by coordination and the dependence structure created through specialization.

12.22.8 Epistemic Dependence

Epistemic dependence arises when economically consequential judgment or action relies on knowledge, interpretation, classification, credibility, expertise, data, or inference supplied by others. Complex economies make some degree of epistemic dependence pervasive because participants cannot independently reproduce the knowledge required for every technical, legal, financial, medical, scientific, organizational, or infrastructural decision.

Epistemic dependence can be productive. Specialization allows complex knowledge to be developed and used without requiring each participant to master the full epistemic chain. It can also create vulnerabilities when expertise is opaque, alternatives are absent, provenance is weak, verification is costly, or one intermediary controls classification and interpretation. These problems become especially consequential where epistemic authority is linked to resource allocation, eligibility, credit, employment, risk classification, or public decision-making.

The analysis should therefore distinguish dependence on information from dependence on interpretation and from dependence on authority to validate a claim. A subject can possess raw data while depending on another actor for technical interpretation; an organization can possess expertise while depending on a regulator's certification; a decision maker can receive multiple expert assessments while depending on institutional procedures for determining which assessment receives uptake.

Remark 12.119 (Epistemic dependence and verification). Epistemic dependence does not require the dependent subject to reproduce the entire knowledge process independently. The relevant practical question is whether the dependence is accompanied by suitable forms of provenance, contestability, cross-checking, accountability, or alternative expertise for the stakes and uncertainty involved.

12.22.9 Mutual and Asymmetric Dependence

Economic dependence can be mutual while remaining unequal in degree, timing, alternatives, or consequences. Two firms can rely on each other while one possesses more substitute partners. An employer can depend on specialized workers while workers depend more immediately on income. A platform can depend on participant activity while individual participants depend more strongly on access to the platform. A household and a care provider can be mutually reliant while differing substantially in exit options and exposure to interruption.

Mutual dependence can support cooperation because participants possess reasons to maintain a relation, invest in coordination, share information, or develop joint capacity. It can also become fragile where the forms of dependence are differently timed or where one party can absorb interruption more easily. Dependence should therefore be decomposed across dimensions such as resource criticality, substitutability, switching cost, time to replacement, legal protection, information, outside options, and capacity to delay.

Asymmetric dependence can contribute to power, but the relation should be established through mechanism rather than treated as a synonym for power. The next analytical level concerns how asymmetries in resources, capacities, information, institutions, time, and relational position are converted into durable differences in influence or constraint. The present section remains focused on the dependence architecture

itself.

Proposition 12.120 (Dimension-specific dependence asymmetry). *Dependence asymmetry is dimension-specific. Mutual dependence in one resource, capacity, or time horizon can coexist with strong asymmetry in another. Aggregate labels such as “interdependent” or “dependent” should therefore be decomposed when the distribution of alternatives, switching costs, exposure, or control is consequential to the inquiry.*

12.22.10 Transformation of Dependence Relations

Dependence relations can change through diversification, substitution, vertical integration, standardization, interoperability, portability, redundancy, inventories, learning, technological change, institutional reform, collective organization, mutualization, regulation, or the creation of new alternatives. These transformations can reduce reliance on one relation while relocating dependence to another part of the configuration.

Diversifying suppliers can reduce concentration while increasing coordination complexity. Vertical integration can reduce dependence on an external supplier while increasing dependence on internal managerial, financial, or technical capacities. Standardization and interoperability can lower switching costs while creating dependence on standard-setting institutions or shared infrastructures. Automation can reduce dependence on selected human tasks while increasing dependence on data, computation, energy, software maintenance, or specialized technical expertise. Collective organization can reduce isolated actors’ dependence on a dominant counterparty while creating new internal governance requirements.

Dependence transformation should therefore be evaluated as relational reconfiguration. The relevant question is not simply whether dependence decreased, but which capacities became more or less dependent on which actors, infrastructures, institutions, or histories, over what horizon, and with what new vulnerabilities or options.

Proposition 12.121 (Dependence reconfiguration). *An intervention that weakens one dependence relation can create, relocate, or deepen other dependence relations. Analysis of dependence transformation should therefore trace the configuration before and after the change rather than infer increased autonomy from the reduction of a single dependency.*

Proposition 12.121 also clarifies why coordination and dependence should be studied together. New coordination mechanisms can expand collective capacity while redistributing reliance, switching costs, knowledge concentration, and exposure to interruption. The economic significance of coordination therefore includes both what coordinated activity makes possible and the dependence architecture through which those possibilities are sustained.

Remark 12.122 (Revisable coordination and dependence categories). The categories developed in this section are provisional analytical resources. New organizational forms, digital infrastructures, artificial agents, institutional arrangements, and historical conditions can produce coordination and dependence mechanisms that fit these categories only partially. GRE should permit the categories and their combinations to be revised when the empirical field requires a different representation.

12.23 Economic Asymmetry

Economic asymmetry concerns differences in economically consequential positions that arise within relational configurations. Such differences may concern resources, capabilities, information, epistemic standing, relational alternatives, institutional positions, timing, exposure, or other dimensions. This section develops asymmetry as a descriptive and explanatory category within the relational architecture of economic systems. Its objective is to distinguish several recurrent forms, examine how asymmetries can be converted across dimensions, and identify mechanisms through which they can persist or change. The discussion is conceptual and comparative. It draws selectively on capability analysis, distributed-knowledge arguments, institutional economics, resource-dependence research, and studies of asymmetric governance relations while keeping normative evaluation and power analysis analytically separate (Sen 1985; Sen 1992; Hayek 1945; North 1990; Pfeffer and Salancik 1978; Gereffi et al. 2005). Table 12.25 summarizes the principal dimensions developed here.

Asymmetry is relational and dimension-specific. Two subjects can occupy similar positions in one dimension and markedly different positions in another. A worker and employer may have comparable technical knowledge while differing in authority, asset ownership, liquidity, or exit alternatives. Two firms can hold similar financial resources while differing sharply in regulatory access, information, technical standards, or bargaining alternatives. Aggregate labels such as “advantaged” and “disadvantaged” can therefore conceal the mechanisms through which a particular difference becomes economically consequential.

Definition 12.123 (Economic asymmetry). For a specified economic relation or configuration, *economic asymmetry* is a difference between positions in an economically consequential dimension whose effects depend on the surrounding relational, institutional, temporal, and historical conditions. An asymmetry analysis should identify the relevant dimension, the positions being compared, the mechanism through which the difference matters, the scale and horizon of analysis, and the conditions under which the asymmetry can change.

Definition 12.123 treats asymmetry as more specific than difference alone. Differences become analytically important when they affect capacities, feasible actions, exposure, bargaining alternatives, access, recognition, expectations, or later relation formation. The existence of such a difference does not by itself determine whether it is efficient, harmful, unjust, legitimate, temporary, or durable. Those evaluations require additional normative and empirical premises.

Proposition 12.124 (Dimension-specific asymmetry). *Economic asymmetry should be attributed to specified dimensions and mechanisms. Similarity in one dimension does not establish symmetry in others, and asymmetry in one dimension does not establish a general ordering of the subjects or configurations involved.*

Before a symmetry or asymmetry judgment is attributed, the comparison itself must also be sufficiently articulated. GRE distinguishes two different limitations. In one case, a comparison is well formed but the available evidence is insufficient to determine whether the compared positions satisfy the relevant symmetry condition. That is an epistemic uncertainty about an applicable predicate. In another case, the positions, retained relational content, or comparison operation required for the judgment are not yet defined at the selected analytical resolution. In that case the symmetry–asymmetry distinction is not yet a well-formed description of the

configuration.

Definition 12.125 (Asymmetry-applicability condition). A classification of positions as symmetric or asymmetric relative to a declared economic dimension is *applicable* only where the compared positions, the relational content retained by the comparison, and the relevant comparison, exchange, ordering, or transformation rule are sufficiently defined at the selected scale and resolution. Where one of these conditions is absent, the analysis should record non-applicability or partial definedness rather than infer symmetry or asymmetry.

Definition 12.125 gives positive analytical content to cases in which economic differentiation has not yet stabilized into a comparison structure. A new institutional field can contain emerging roles whose boundaries remain unsettled; a new technology can reorganize relations before stable categories of access or control have formed; an evolving value regime can lack a settled conversion or ordering rule. Such cases are not thereby symmetric. The relation required to test symmetry can itself still be under formation.

Proposition 12.126 (Antecedent-regime plurality). *A well-formed economic asymmetry can be analyzed under at least three model-relative antecedent conditions: an articulated symmetry that is later reduced; an asymmetry treated as antecedent within the selected model domain; or a pre-differentiated regime in which the relevant comparison becomes well formed only after further relational articulation. Observation of the later asymmetry does not by itself determine which antecedent condition applies.*

The proposition is methodological rather than metaphysical. An analysis can begin from the earliest asymmetric structure warranted by its evidence without claiming that asymmetry is ontologically fundamental. Likewise, a symmetry-breaking account is appropriate only where an antecedent symmetry has been independently specified. A pre-differentiated regime is not a third truth value beside “symmetric” and “asymmetric”; it identifies a case in which the predicate itself lacks a complete domain of application. This distinction allows later formal work to use group-theoretic symmetry, partial transformations, or other structures only where their assumptions are earned by the economic problem.

Table 12.25 is an open analytical repertoire rather than a complete taxonomy. A single economic relation can contain several asymmetries at once, and the significance of each can change over time. The analytical task is therefore to identify the differences that matter for the problem under study and to reconstruct their interactions without presuming a single master dimension.

12.23.1 Resource Asymmetry

Resource asymmetry concerns differences in effective command over resources relevant to an economic process. The resource categories developed in Section 12.16 include material, financial, temporal, spatial, informational, knowledge, attentional, infrastructural, institutional-access, and relational resources. Resource asymmetry therefore extends beyond differences in wealth or income. Subjects can possess comparable financial resources while differing materially in time, infrastructure, credentials, social relations, or access to institutions.

The economic significance of resource asymmetry depends on conversion conditions. A nominally scarce resource can have limited effect where substitutes are abundant, while a modest difference can become consequential where the resource

Table 12.25: Selected dimensions of economic asymmetry and their analytical questions.

Dimension	Illustrative asymmetry	Questions requiring specification
Resource	Unequal command over material, financial, temporal, spatial, infrastructural, or relational resources	Which resource matters for which capacity, how accessible and substitutable is it, and over what horizon?
Capability	Different effective abilities to act, produce, learn, negotiate, coordinate, adapt, or exit	Which conversion conditions translate resources and relations into effective capacity?
Information	Unequal possession, timing, quality, granularity, or accessibility of economically relevant information	Who knows what, when, with what reliability, and how does the difference alter action or exchange?
Epistemic	Different capacities to interpret, validate, classify, model, explain, or establish credible knowledge	Which position can make sense of evidence, challenge representations, or define accepted knowledge?
Relational	Different alternatives, network positions, dependencies, access channels, or replacement possibilities	Which relations provide options, brokerage, support, or vulnerability, and how substitutable are they?
Institutional	Different rights, statuses, procedural access, recognition, rule-setting positions, or enforcement exposure	Which institutional arrangements create or stabilize the difference, and how revisable are they?
Temporal	Different waiting capacity, urgency, sequencing position, exposure to delay, or control over timing	Who can wait, accelerate, postpone, or impose timing on others, and what future options are affected?
Conversion	Capacity to transform one asymmetry into another, such as resources into expertise, access, or control	Which conversion mechanism operates, with what losses, delays, complementarities, and barriers?
Persistence	Reproduction of an asymmetry through cumulative advantage, path dependence, institutionalization, or recurrent conversion	Which mechanism reproduces the difference, and which events could weaken, redirect, or reverse it?

is indispensable, difficult to replace, or complementary to other capacities. Resource-dependence analysis is relevant here because organizations can become constrained by external control over consequential resources, especially where alternatives are limited (Pfeffer and Salancik 1978).

Resource asymmetry should also be separated from resource inequality measured at one moment. Timing, reliability, liquidity, location, enforceability, and future access can make two equal nominal stocks generate different practical positions. A subject with a smaller but reliable resource flow can sometimes possess greater effective security than another with a larger but highly volatile or inaccessible stock.

Remark 12.127 (Resource asymmetry and practical command). Resource asymmetry is most informative when the analysis states the capacity for which the resource matters and the conditions under which it can be mobilized. Nominal holdings alone can be an incomplete proxy for practical command.

12.23.2 Capability Asymmetry

Capability asymmetry concerns differences in what subjects or configurations can effectively do under their existing resources, relations, institutions, and histories. It therefore builds on the resource–capacity distinction developed in Section 12.17. Capability-oriented economic reasoning has long emphasized that similar resources can yield different substantive opportunities because conversion conditions differ across persons and environments (Sen 1985; Sen 1992).

Within GRE, capability asymmetry can concern production, learning, coordination, interpretation, negotiation, innovation, mobility, adaptation, resistance to interruption, or exit. Such asymmetries can exist between individuals, households, firms, public institutions, communities, platforms, or other configurations. Their significance depends on which capability is relevant to the process being analyzed.

Capability differences can also be relationally generated. Specialized infrastructure, organizational routines, legal recognition, accumulated trust, complementary expertise, or established standards can enable one participant to exercise a capacity that another cannot reproduce independently. This does not imply that the capacity belongs exclusively to one entity; it may be distributed across a wider configuration.

Proposition 12.128 (Resource–capability asymmetry non-equivalence). *Differences in resources do not determine differences in effective capability without specifying the conversion conditions connecting resources to action. Capability asymmetry can therefore be greater, smaller, or differently structured than the resource asymmetry observed at the same moment.*

12.23.3 Information Asymmetry

Information asymmetry concerns differences in access to economically relevant information, including its timing, precision, granularity, reliability, or interpretability. Economic coordination commonly occurs under dispersed and incomplete knowledge, so information differences are a normal feature of many economic systems rather than an exceptional disturbance (Hayek 1945). The relevant question is which differences affect decisions, expectations, exchange conditions, monitoring, or later opportunities.

Information asymmetry can arise through specialization, privacy, proprietary control, unequal observation, technical systems, organizational boundaries, timing, or strategic disclosure. It can also be produced by institutional classifications and reporting procedures that make some states visible to particular actors while leaving others opaque. The same informational difference can have different consequences depending on whether it can be verified, shared, inferred, substituted, or challenged.

Information quantity is an incomplete measure of informational position. Access to large datasets can coexist with poor relevance, weak provenance, delayed observation, or inadequate contextual interpretation. Conversely, a locally situated actor

can possess narrow but highly consequential information unavailable to a larger organization. Information asymmetry should therefore be reconstructed through the decision or relation in which the information matters.

12.23.4 Epistemic Asymmetry

Epistemic asymmetry is broader than informational asymmetry. It concerns differences in the capacities and recognized positions through which information is interpreted, validated, classified, modeled, communicated, or accepted as credible knowledge. Two actors may possess the same data while differing in technical expertise, conceptual frameworks, institutional authority, interpretive resources, or the ability to contest an established representation.

Epistemic asymmetry can therefore arise through expertise, education, professional certification, data infrastructure, model access, language, institutional credibility, or control over classificatory procedures. It can also be distributed: one actor may possess domain knowledge, another statistical expertise, and another procedural or local knowledge. The epistemic structure of an economic process can thus involve complementarities as well as inequalities.

The distinction matters because decisions can depend on who is authorized or practically able to define the relevant state of the system. Credit ratings, audits, technical certifications, eligibility classifications, forecasts, and platform metrics can shape action when other participants depend on the institutions or systems that produce them. Where such representations become performative, epistemic asymmetry can alter the relational field as well as describe it.

Remark 12.129 (Epistemic asymmetry and epistemic dependence). Epistemic asymmetry and epistemic dependence are related but distinct. An actor can know less than another without depending on that actor's judgment, while strong dependence can arise where one actor's interpretation or certification is difficult to replace even if informational differences are modest.

12.23.5 Relational Asymmetry

Relational asymmetry concerns differences in positions within economic relations and relational configurations. Relevant dimensions can include alternative partners, brokerage positions, switching costs, dependency, access channels, reputation, support relations, contractual options, or the ability to coordinate with others. The same nominal resource endowment can generate different practical positions when relational alternatives differ.

A bilateral relation can become asymmetric where one participant can replace the other at low cost while the reverse is difficult. A network can generate asymmetry where one subject occupies a bridging or gatekeeping position connecting otherwise separated participants. An organization can produce asymmetry through differentiated authority, reporting, or access to decision processes. These mechanisms should be specified separately because they imply different possibilities for change.

Relational asymmetry is also dynamic. A relation that initially provides mutual benefit can generate accumulated specialization, switching costs, shared infrastructure, or reputational investment that later changes the parties' alternatives. Conversely, new standards, intermediaries, networks, or institutions can create substi-

tutes and reduce an earlier asymmetry. The relevant object is therefore the evolving relation among positions rather than a fixed attribute of either party.

12.23.6 Institutional Asymmetry

Institutional asymmetry concerns differentiated positions created or stabilized through rules, legal statuses, administrative procedures, classifications, recognition, enforcement, and access to institutional channels. Institutions can assign different rights, duties, liabilities, procedural opportunities, evidential burdens, or powers to different categories of participant. These differences may serve coordination, protection, specialization, representation, or other purposes, while their effects remain dependent on the surrounding historical and normative context.

Institutional asymmetry can persist even where formal rules use symmetrical language. Differences in information, legal assistance, administrative capacity, documentation, geographic access, recognition, or enforcement exposure can produce unequal effective positions under the same nominal rule. Institutional analysis therefore benefits from distinguishing written rules from enacted and practically accessible institutional relations (North 1990).

Institutions can also alter other asymmetries. Public infrastructure, procedural protections, standardization, portability, social insurance, collective bargaining arrangements, or access rules may reduce some resource or relational asymmetries. Licensing, classification, exclusivity, procedural complexity, or differential enforcement can increase others. The direction and magnitude of the effect remain empirical questions.

12.23.7 Temporal Asymmetry

Temporal asymmetry concerns differences in the capacity to wait, accelerate, postpone, synchronize, commit, recover, or impose timing within an economic process. Time is therefore relevant as a resource and as a relational position. A participant with greater liquidity may be able to wait for favorable terms; a debtor facing an imminent deadline may accept conditions that would be unattractive under a longer horizon; an organization controlling schedules or queues may shape others' feasible actions through timing alone.

Temporal asymmetry can also arise through information arrival and decision speed. One actor may observe changes earlier, update models faster, execute transactions more quickly, or absorb delay more easily. These advantages can be transient, recurrent, or institutionally stabilized. Their consequences depend on the tempo of the process and on whether delayed action can be recovered later.

Historical sequencing adds a further dimension. Early access to infrastructure, standards, networks, or institutional recognition can create cumulative advantages even after later participants obtain formally similar access. Path-dependent adoption and increasing returns provide established mechanisms through which early sequences can remain economically consequential (Arthur 1989). Temporal asymmetry therefore includes both immediate timing differences and historically inherited positional differences.

Remark 12.130 (Temporal position and waiting capacity). Temporal asymmetry is especially important where delay changes bargaining alternatives, resource depletion,

legal status, learning opportunities, or access to future options. Equal calendar time does not imply equal capacity to bear delay.

12.23.8 Asymmetry Conversion

Asymmetries can be converted across dimensions. Financial resources can finance expertise, infrastructure, legal representation, or waiting capacity. Epistemic advantages can improve access to resources or institutional procedures. Relational positions can provide information, reputation, coordination opportunities, or preferential access. Institutional standing can stabilize control over resources or improve the credibility of claims. Capability differences can generate later resource or relational differences through repeated performance and selection.

Conversion is conditional and can be asymmetric, lossy, delayed, or reversible. It depends on institutions, technologies, norms, complementary resources, timing, and relational position: resources may fail to yield epistemic authority without credibility, knowledge may have little effect without decision access, and institutional status may weaken where enforcement is limited.

For GRE, asymmetry conversion is analytically important because a modest difference in one dimension can become consequential when it opens pathways into several others. Conversely, policies or organizational changes that equalize one visible dimension can leave the wider configuration largely unchanged if conversion mechanisms remain asymmetric.

Proposition 12.131 (Situated asymmetry conversion). *Conversion of asymmetry across dimensions depends on identifiable relational and institutional mechanisms. The presence of an advantage in one dimension does not establish its convertibility into another, and successful conversion in one historical configuration need not transport unchanged to another.*

12.23.9 Persistent Asymmetry

Persistent asymmetry concerns differences reproduced across time through recurrent mechanisms such as cumulative returns, path dependence, institutionalization, inheritance, network position, learning, standards, resource accumulation, dependency, or repeated conversion across dimensions. Persistence can survive turnover in the actors occupying particular positions when the reproducing mechanism is organizational or institutional.

Persistence is distinct from permanence. Economic asymmetries can weaken, intensify, migrate across dimensions, or disappear as technologies, institutions, networks, or collective capacities change; similar measured differences can also be sustained by changing mechanisms. Their normative standing remains open: differentiated roles may support coordination, while other asymmetries may generate vulnerability, exclusion, concentration, or restricted alternatives.

Mechanism-specific persistence is therefore the operative analytical claim: repeated observation of a similar distribution does not identify the process reproducing it, and recurrent conversion, institutional reproduction, cumulative advantage, relational dependence, and other mechanisms imply different possibilities for transformation.

12.24 Symbolized Economic Relations

Economic relations are frequently mediated by symbols, records, categories, measures, and formal representations. This section develops symbolized economic relations as a component of economic architecture: legal statuses, administrative categories, accounts, statistics, contracts, prices, credit records, and digital representations can render selected relations visible, comparable, actionable, and transferable across institutional settings. The objective is to distinguish the economic relation from its representation while examining the conditions under which representations acquire causal significance. The discussion proceeds comparatively across major representational forms, then examines mismatch, revisability, performativity, and epistemic events. The method is interpretive and institutional, with ontological restraint: representations are treated as historically situated interfaces to economic relations rather than as complete replicas of the relations they describe. Work on quantification, classification, and commensuration provides established reasons to examine how representational practices shape visibility and comparability while preserving the distinction between measurement and the underlying object (Porter 1995; Desrosières 1998; Espeland and Stevens 1998; Bowker and Star 1999).

Definition 12.132 (Symbolized economic relation). A *symbolized economic relation* is an economic relation whose recognition, coordination, evaluation, transfer, enforcement, or practical accessibility is mediated in part through a symbolic or representational form. The representation may record an existing relation, constitute an institutionally recognized position, coordinate expectations, or participate in changing later economic behavior.

The definition does not require a strong distinction between a fully formed “real” relation and a merely secondary symbol. Some relations, including many legal, monetary, contractual, accounting, and administrative positions, are partly constituted through recognized symbolic forms. At the same time, institutional recognition does not imply that the symbolic form exhausts the wider history, dependence, capability, or relational consequences associated with the position. The analytical task is therefore to identify what the representation makes actionable, what it omits, and how it enters the subsequent evolution of the economic field.

Table 12.26 summarizes the principal representational forms developed in this section. The list is illustrative. A single economic relation can be represented simultaneously through several forms, and the same representational form can support different mechanisms in different institutional settings.

12.24.1 Legal Representation

Legal representation gives selected economic relations institutionally recognized form through legal categories, titles, rights, duties, powers, liabilities, immunities, procedures, and remedies. A property title, corporate status, employment classification, security interest, license, entitlement, fiduciary position, or legal personality can make a relation legible to courts, administrators, counterparties, and other institutions. Hohfeld’s analytical decomposition of legal positions is useful here because it shows that legal relations can be represented through differentiated correlatives rather than through a single undifferentiated idea of a “right” (Hohfeld 1919).

Legal representation can be constitutive as well as descriptive. Recognition of own-

Table 12.26: Illustrative forms of symbolized economic relations and their analytical roles.

Form	Typical represented object	Possible economic role	Analytical caution
Legal	rights, duties, powers, liabilities, status	recognition, enforceability, transfer, authority	legal position may differ from practical control or access
Administrative	eligibility, category, compliance status, identity	allocation, monitoring, authorization, exclusion	categories can simplify heterogeneous histories
Accounting	assets, liabilities, flows, costs, revenues	organizational memory, comparison, control, reporting	recorded boundary and valuation rules are constructed
Statistical	populations, sectors, aggregates, distributions	comparison, policy observation, model calibration	aggregation can hide internal heterogeneity
Contractual	commitments, contingencies, permissions, remedies	expectation, coordination, obligation, risk allocation	written terms may differ from enacted relations
Price	exchange ratios and market quotations	coordination, comparison, signaling, settlement	price does not uniquely identify underlying relations
Credit	claims, repayment histories, ratings, limits	deferred exchange, screening, access, future obligation	representation can affect the capacity it purports to assess
Digital	identities, scores, logs, tokens, rankings, platform states	automation, portability, filtering, access control	technical encoding can concentrate classificatory power

ership can change transferability, exclusion, liability, financing possibilities, inheritance, or the availability of remedies. Recognition of an organization as a legal person can stabilize contracts and obligations across membership turnover. Classification of a worker, asset, creditor, or beneficiary can alter the rights and duties attached to the position. The legal representation therefore enters the economic relation through institutional consequences.

The effective relation can nevertheless differ from the legal representation. Formal ownership may coexist with weak practical control; legal entitlement may be difficult to exercise; a formally independent contractor may occupy a relation with strong practical dependence; and informal claims may remain economically consequential even where formal recognition is limited. GRE therefore treats legal form as one important layer of relational architecture whose causal significance depends on enactment, enforcement, access, and interaction with other relations.

Remark 12.133 (Legal representation and relational remainder). A legal representation can stabilize selected dimensions of a relation while leaving other dimensions outside its formal description. Historical dependence, trust, tacit obligations, informal authority, social recognition, and practical switching costs can remain economically consequential after the legal position has been specified.

12.24.2 Administrative Representation

Administrative representation operationalizes economic relations through categories, records, identifiers, eligibility determinations, procedural statuses, compliance codes, files, registries, and other forms used by organizations and public authorities. These representations often translate general institutional rules into determinate decisions about who or what is recognized, counted, monitored, authorized, paid, taxed, inspected, sanctioned, or granted access.

Administrative representations depend on classification. Classification can make heterogeneous cases comparable enough for recurrent decision processes, but it also selects which distinctions become institutionally visible. Work on classification systems emphasizes that categories and standards can become infrastructural: once embedded in forms, databases, routines, software, reporting requirements, and professional practices, they organize how cases enter institutional processes (Bowker and Star 1999). The economic significance of a category therefore depends partly on the decisions and relations attached to it.

Administrative representation can also generate feedback. A category used to determine eligibility can induce subjects to reorganize documentation, timing, organizational form, or behavior around the classification. A compliance indicator can alter monitoring priorities. A standardized identity or registration status can create new channels of access while closing others. Such effects are empirical and institution-specific; the existence of an administrative category alone does not establish strong performativity.

12.24.3 Accounting Representation

Accounting representation organizes selected economic events and positions into records such as assets, liabilities, revenues, expenses, capital accounts, inventories, receivables, provisions, and cash flows. These records create a durable representational layer through which organizations remember transactions, compare periods, coordinate responsibilities, report to external parties, and make decisions about resources and obligations.

Accounting representation requires boundaries and valuation rules. A record depends on which entity is being represented, which event belongs to the reporting period, which asset or liability is recognized, how uncertain claims are treated, and which valuation convention is applied. These choices need not be arbitrary, but they are institutional and methodological decisions rather than transparent copies of an independently partitioned economic world. Standardized accounting can therefore increase comparability while also stabilizing particular ways of seeing organizational resources and obligations.

At macroeconomic scale, systems of national accounts provide a particularly clear example of institutionalized representation: economic activities are organized into standardized institutional units, sectors, transactions, stocks, and flows so that otherwise heterogeneous processes can be compared and aggregated (European Commission et al. 2009). The resulting representations can be indispensable for analysis while remaining dependent on definitions, boundaries, imputations, and aggregation rules.

Proposition 12.134 (Accounting representation and organizational action). *Where*

accounting categories are linked to budgets, covenants, performance evaluation, taxation, reporting duties, or managerial authority, changes in accounting representation can alter feasible organizational action even when the underlying material configuration has not changed to the same degree.

12.24.4 Statistical Representation

Statistical representation constructs populations, variables, distributions, indices, aggregates, classifications, and comparable series from selected observations. In economic systems, statistical representations can support diagnosis, comparison, forecasting, resource allocation, policy evaluation, and public communication. Their usefulness often depends on standardization across cases and time.

Statistical comparability is historically and institutionally produced. Categories such as employment, industry, household, sector, output, poverty, productivity, or price level require operational definitions and procedures for classification, sampling, aggregation, and revision. Desrosières' history of statistical reasoning shows how statistical conventions combine technical practices with institutional settlements about equivalence and comparability (Desrosières 1998). Quantitative objectivity can support impersonal coordination, yet standardized measures can also suppress distinctions that matter for particular questions (Porter 1995).

For GRE, statistical representation therefore has two simultaneous roles. It can reveal patterns that are difficult to perceive at the level of individual cases, and it can compress heterogeneous histories into a common representational space. Neither role is sufficient by itself to establish whether the representation is appropriate for a given decision. Aggregation, measurement error, category drift, missingness, selection, and changes in the data-generating process remain relevant to interpretation.

Remark 12.135 (Aggregation and relational heterogeneity). An aggregate can remain empirically useful while concealing differences in access, dependency, exposure, authority, or historical position among the units included in it. Disaggregation is therefore a problem-relative methodological choice rather than an automatic correction.

12.24.5 Contractual Representation

Contractual representation gives selected commitments, contingencies, permissions, duties, claims, remedies, and procedures a durable symbolic form. Contracts can coordinate expectations across time by specifying what participants may do, are expected to do, or can claim under stated conditions. They can also allocate risks, define transfer conditions, structure monitoring, and establish procedures for amendment, termination, or dispute.

The contract is both a representation of an intended relation and, where institutionally recognized, part of the relation itself. Institutional economics has long treated transactions and working rules as central to the organization of economic action (Commons 1931). A written contract can therefore affect bargaining, finance, authority, and future options even before the represented contingency occurs.

Contractual completeness remains limited by uncertainty, interpretation, enforcement costs, changing circumstances, tacit expectations, and the practical impossibility of specifying every relevant future state. Enacted relations can consequently diverge from written terms without making the contract economically irrelevant. GRE treats

the contractual document, the legal-institutional framework, and the evolving practical relation as analytically distinguishable layers whose interaction must be reconstructed for the problem under study.

12.24.6 Price Representation

Prices symbolically represent exchange relations through quantities denominated in a unit of account. They can compress dispersed information about offers, expectations, scarcity conditions, costs, preferences, inventories, financing, strategic behavior, and institutional constraints into a form that participants can use for comparison and coordination. Hayek's account of dispersed knowledge remains an influential articulation of the coordinating role that price changes can play where relevant knowledge is distributed across many actors (Hayek 1945).

A price is nevertheless a selective representation. Similar observed prices can arise from different market structures, bargaining relations, information conditions, subsidies, taxes, market power, contractual terms, or expectations. Conversely, economically similar relations can be represented by different prices because of location, timing, risk allocation, quality, access conditions, or institutional differences. Price representation therefore should not be treated as a unique inverse map to the underlying relational configuration.

Prices can also become reference points for later action. Quoted prices can affect expectations, collateral valuation, contractual triggers, accounting marks, portfolio constraints, negotiations, or public perceptions. This possibility connects price representation to performativity without implying that every price movement is performative in a strong sense.

Proposition 12.136 (Price–configuration non-invertibility). *Observed price relations generally underdetermine the wider relational configuration that generated them. Inference from price to economic structure therefore requires additional evidence about institutions, participation, information, timing, bargaining, and other relevant mechanisms.*

12.24.7 Credit Representation

Credit relations depend heavily on symbolic representations of future obligation and anticipated capacity. Promissory claims, balances, repayment histories, collateral records, ratings, scores, limits, covenants, and risk classifications can mediate access to present resources in exchange for future obligations. Credit representation therefore connects current positions to expectations about later histories.

These representations are necessarily selective. A credit score or rating compresses a heterogeneous history into a tractable classification or numerical signal. A balance records contractual obligations but may not capture informal support, future institutional change, or the relational consequences of default. A collateral valuation represents one dimension of recoverability while depending on market conditions, legal enforceability, timing, and transaction costs.

Credit representation can become self-reinforcing where access to finance affects the later capacity that the representation was intended to assess. A classification that raises borrowing costs can reduce liquidity and investment capacity; an improved rating can expand access and alter future options. Such feedback does not establish

that the original representation was false or arbitrary. It does mean that assessment and subsequent economic evolution may become coupled.

12.24.8 Digital Economic Representation

Digital economic representation encodes economic positions and relations in machine-readable forms such as identifiers, account states, transaction logs, scores, tokens, credentials, rankings, digital contracts, access permissions, recommendation states, and platform records. Digital encoding can make representations rapidly searchable, replicable, transferable, combinable, and executable across organizational processes.

The economic consequences depend on how the representation is embedded. A digital credential can mediate institutional access; a platform score can influence visibility or matching; a transaction log can support settlement or audit; a token can represent a claim, permission, or transfer state; and an automated classification can trigger differentiated treatment. Computational systems can therefore connect representation directly to action at speeds and scales that differ from many paper-based processes.

Digital representation can also concentrate control over categories, interfaces, data provenance, update rules, and error correction. Accountability may therefore require technical and institutional mechanisms capable of examining consequential computational procedures rather than relying only on ordinary review of individual human decisions (Kroll et al. 2017). GRE does not infer opacity or domination from digital mediation alone; the relevant questions concern control, contestability, alternatives, provenance, and the consequences attached to the encoded state.

Remark 12.137 (Digital representation and functional dependence). A digital representation becomes economically infrastructural when recurrent activities depend on its continued recognition, interoperability, or update rules. The degree of dependence remains an empirical property of the surrounding configuration rather than a property of digitality itself.

12.24.9 Representational Error and Mismatch

Economic representations can diverge from the relations they are intended to track. Error can arise through inaccurate observation, outdated data, coding mistakes, model misspecification, category mismatch, aggregation, strategic reporting, incomplete records, measurement noise, or changes in the represented system. A representation can also be internally accurate according to its own rules while remaining poorly matched to the practical question for which it is later used.

GRE therefore distinguishes several forms of mismatch. *Observational mismatch* concerns inaccurate or incomplete recording. *Categorical mismatch* concerns a classification that groups together cases whose relevant mechanisms differ. *Temporal mismatch* arises when the representation describes an earlier configuration that has materially changed. *Scale mismatch* arises when a representation valid at one level is transported to another without adequate justification. *Functional mismatch* concerns the use of a representation for a task different from the one for which its construction and validation are appropriate.

The possibility of mismatch does not imply that symbolic representation should

be avoided. Economic coordination at large scale often depends on compression, abstraction, and standardization. The methodological requirement is proportionate: the consequentiality of the decision, the possibility of correction, and the uncertainty of the representation can affect how much validation, provenance, disaggregation, or contestability is appropriate.

Remark 12.138 (Representation error and practical consequence). The practical significance of a representational error depends on the action architecture attached to it. The same measurement error can be negligible in exploratory analysis and consequential when it automatically determines eligibility, financing, sanctions, or irreversible commitment.

12.24.10 Revisability of Economic Representations

Economic representations operate in changing fields. Legal categories are amended, administrative records corrected, accounting treatments revised, statistical series re-based, contracts renegotiated, prices updated, credit assessments changed, and digital states recomputed. Revisability is therefore a structural property of many representational systems rather than evidence that representation has failed.

A useful revision architecture distinguishes correction from reclassification and from transformation of the represented relation. Correction changes the representation because the earlier record was inaccurate. Reclassification changes the representational scheme or category. Relational transformation changes the underlying economic position itself. These processes can occur together but should not be conflated because they imply different historical interpretations.

Revision also creates continuity problems. A revised statistical classification can reduce comparability with earlier periods; a corrected administrative status can leave residual consequences from actions taken under the earlier status; a changed credit assessment may not undo financing constraints already experienced; and a revised digital record can remain copied across other systems. Historical analysis should therefore retain provenance where earlier representations materially affected action.

Proposition 12.139 (Revision with representational provenance). *Where an economic representation has already influenced consequential action, later revision should analytically preserve the earlier representational state and its practical consequences when those consequences remain relevant to the history under study.*

12.24.11 Performative Economic Representation

Some economic representations do more than record or summarize a field. They can enter the field through decisions, expectations, incentives, classifications, contracts, models, or institutional responses and thereby contribute to changing later relations. MacKenzie's analysis of financial models provides a well-known case in which representations can become incorporated into market practice rather than functioning only as external descriptions (MacKenzie 2006). Research on rankings similarly demonstrates how public measures can generate reactivity through organizational responses and self-reinforcing behavior (Espeland and Sauder 2007).

GRE uses *performative representation* in a conditional sense. Performativity requires an identifiable coupling between the representation and subsequent economic

action. A forecast may influence investment; a rating may alter financing access; a classification may change eligibility; an index may become a contractual benchmark; an accounting threshold may trigger organizational action. The representation then participates in the history that produces later observations.

This coupling can strengthen, weaken, or transform the apparent validity of the representation. A prediction can contribute to its own realization, contribute to its own invalidation, or change the system in ways that make the original model less transportable. The analysis therefore requires attention to uptake, authority, institutional embedding, alternatives, and the population or process affected by the representation.

Proposition 12.140 (Conditional performativity of economic representation). *An economic representation is performative to the extent that its production, communication, recognition, or institutional uptake contributes through identifiable mechanisms to changes in the economic relations or histories subsequently observed. Representational salience alone does not establish performativity.*

12.24.12 Epistemic Events in Economic Fields

An epistemic event provides a broader frame for representations whose practical uptake changes economic evolution. It can include observation, classification, recognition, model output, communication, interpretation, or institutional acknowledgment that changes what relevant subjects know, expect, can contest, or are authorized to do. Symbolized economic relations provide recurrent channels through which such events enter economic fields.

The same representation can function as a readout or as a field-changing event. A statistical release can remain observational or alter expectations and policy; a credit assessment can remain diagnostic or become a gatekeeping event; a legal judgment can interpret an existing relation while changing recognized future positions. The distinction therefore depends on uptake, authority, and consequential action rather than on representational form alone.

Economic representations can also participate in recursive observation–action processes: representations shape action, action changes relations, and later representations arise from the changed field. Historical reconstruction can distinguish the represented state from the representational event and its uptake where evidence permits.

Where a symbolic representation changes expectations, permissions, access, commitments, or decisions, the representational event can therefore be treated as part of the economic history rather than only as an external observation.

12.25 Economic Topology and Fields

Economic architecture can be described through named relations and institutions as well as through patterned connection, reachability, positional advantage, interruption, and position-dependent conditions of action. This section develops *economic topology* and *economic field* as optional analytical languages for those features. The objective is to identify when connectivity, centrality, clustering, bridging, bottlenecks, peripheral position, and field-like gradients add explanatory content beyond simpler descriptions of actors and bilateral relations. The discussion proceeds from network-structural properties to resource, capability, knowledge, and trust fields, and con-

only where the relevant economic mechanism is specified, with ontological suspension maintained throughout. Established network analysis provides mature tools for studying relational position and connectivity, while also demonstrating that measures such as centrality and clustering depend on the representation chosen and the substantive process being modeled (Wasserman and Faust 1994; Newman 2003; Freeman 1978; Fortunato 2010).

Definition 12.141 (Economic topology). Within this chapter, an *economic topology* is a representation of economically consequential patterns of connection, separation, reachability, adjacency, pathway, and position within a specified relational configuration. The term is used in an analytical sense unless a formal mathematical topology is explicitly defined.

Definition 12.142 (Economic field). An *economic field* is a representation in which economically relevant conditions, opportunities, constraints, expectations, resources, or capacities vary with relational position. Field language is warranted only when the position-dependent variation and the mechanism through which it matters can be specified.

These definitions separate topology and field from ontology. An economic system does not become literally a graph, metric space, or physical field merely because one of those representations is useful. The same empirical configuration can also be represented through institutions, histories, event complexes, contracts, organizational routines, or other formalisms. Representation choice should therefore be guided by the explanatory question and available evidence, with formal elegance remaining secondary to analytical fit.

Table 12.27 summarizes the principal analytical objects developed in this section. The dimensions overlap: a bridge can also be central, a bottleneck can arise through institutional as well as graph-structural mechanisms, and a peripheral position can retain substantial capability through resources unavailable to more centrally connected positions.

12.25.1 Network Connectivity

Connectivity concerns whether economically consequential positions are linked through pathways that permit some form of transfer, influence, access, coordination, observation, or obligation. A connection can involve exchange, communication, legal relation, ownership, credit, infrastructure, authority, trust, or another relation defined elsewhere in the chapter. Network representations are useful because they make pathway structure explicit, yet the presence of an edge remains an analytical construction whose meaning depends on the relation being represented (Wasserman and Faust 1994; Newman 2003).

Economic connectivity therefore has several dimensions. *Direct connectivity* concerns an immediate relation between positions. *Indirect connectivity* concerns reach through sequences of relations. *Redundant connectivity* concerns the availability of alternative paths. *Temporal connectivity* concerns whether a pathway exists at the relevant time and in the relevant sequence. *Multilayer connectivity* concerns reach across different relation types, such as finance, information, logistics, ownership, and legal recognition, whose interaction may matter for the economic process (Kivelä et al. 2014; Holme and Saramäki 2012).

Connectivity alone does not establish effective access. A path can exist while be-

Table 12.27: Illustrative dimensions of economic topology and field analysis.

Dimension	Analytical question	Possible economic significance	Scope caution
Connectivity	which economically relevant positions are linked or reachable	access, propagation, coordination, redundancy	connection type, direction, weight, and timing matter
Centrality	which positions occupy structurally consequential locations	brokerage, visibility, reach, exposure, coordination	centrality interpretation should match the mechanism
Clustering	where dense local relational structure is concentrated	trust, coordination, redundancy, local closure	dense structure can also restrict alternatives
Bridging	which positions connect otherwise weakly connected regions	brokerage, translation, access to heterogeneous resources	bridge status depends on the selected boundary and relation type
Bottlenecks	where flows or actions depend disproportionately on limited passages	vulnerability, delay, gatekeeping, capacity constraint	apparent bottleneck may disappear under another pathway or scale
Periphery	which positions have limited connection to selected cores or pathways	reduced access, autonomy, specialization, exposure differences	peripheral status is relation- and scale-specific
Resource field	how resource availability varies by relational position	differentiated opportunity and conversion capacity	nominal resource presence may differ from effective access
Capability field	how feasible action varies across positions	heterogeneous action sets and adaptive capacity	capability cannot be inferred from resource location alone
Knowledge/trust field	how epistemic access and relational confidence vary spatially or structurally	learning, coordination, verification, cooperation	knowledge and trust remain mechanism-specific and revisable

ing too costly, slow, capacity-constrained, legally unavailable, institutionally unrecognized, or practically unusable. Conversely, an actor with relatively few ties can retain substantial capability where those ties connect to highly substitutable resources or institutions. The economic interpretation of connectivity therefore requires relation-specific weights, direction, capacity, timing, and access conditions where these features materially affect the problem.

Proposition 12.143 (Connectivity–access non-equivalence). *Relational connectivity does not by itself establish effective economic access. Access depends additionally on the usability, capacity, timing, recognition, and conditions attached to the relevant pathway.*

12.25.2 Relational Centrality

Centrality describes structural prominence relative to a specified network representation. Established network analysis distinguishes several non-equivalent centrality concepts, including degree-like, closeness-like, and betweenness-like measures (Freeman 1978). Weighted-network extensions further show that tie number and tie strength can produce different positional interpretations (Opsahl et al. 2010). GRE therefore treats “central” as incomplete unless the relevant measure and economic mechanism are identified.

A position can be central because it maintains many direct relations, lies on numerous pathways, reaches others through relatively short paths, controls scarce interfaces, or occupies a highly connected layer of a multilayer system. These forms can correspond to different economic capacities. High degree may support information access or transaction opportunities; high betweenness may support brokerage or gatekeeping; proximity to relevant resources may matter even where a position is not globally central.

Centrality can also generate exposure. A highly connected intermediary may face correlated obligations, operational overload, systemic propagation, or dependence on maintaining many relationships. A central platform may coordinate large volumes of activity while becoming a concentrated point of failure. The economic significance of centrality therefore depends on the process being studied and should not be treated as a general scalar ranking of subjects.

Remark 12.144 (Mechanism-specific centrality). A centrality statistic earns economic interpretation only when the pathway represented by the statistic corresponds to a mechanism relevant to the inquiry. Structural prominence in one relation layer need not imply prominence in another.

12.25.3 Relational Clustering

Clustering concerns concentrations of comparatively dense relational connection. Network science provides several approaches to clustering and community structure, while the diversity of methods itself illustrates that clusters depend on modeling choices and need not correspond to naturally given social or economic groups (Newman 2003; Fortunato 2010). In GRE, clustering is therefore treated as a candidate representation of locally concentrated relational structure whose correspondence to a bounded economic community requires separate justification.

Dense local structure can support repeated interaction, reputation, mutual monitoring, coordination, shared conventions, or rapid information circulation. It can also produce redundancy, localized dependence, restricted search, exclusion of outsiders, or vulnerability to shocks shared within the cluster. The relevant consequence depends on relation type, internal heterogeneity, external links, and the broader institutional setting.

Clustering also interacts with the boundaries developed earlier in the chapter. A detected relational cluster may cross legal or organizational boundaries; a formally unified organization may contain several weakly connected clusters; and the cluster most relevant to information may differ from the cluster relevant to finance or authority. Cluster attribution should therefore remain relation- and purpose-specific.

12.25.4 Bridging Positions

A bridging position connects relational regions that would otherwise be more weakly connected under the selected representation. Bridges can be persons, organizations, institutions, infrastructures, standards, intermediaries, legal arrangements, or shared practices. Their economic significance can arise through brokerage, translation, certification, coordination, transfer, or access to heterogeneous resources.

A bridge need not possess formal authority. An accounting standard can bridge organizational domains by making records comparable; a payment infrastructure can bridge otherwise separate markets; a bilingual professional community can bridge knowledge domains; and an intermediary can connect suppliers with buyers while owning neither side of the transaction. Economic bridging is therefore a relational function whose carriers can vary across settings.

Bridging can expand collective capacity while producing dependence on the bridge. Where alternatives are scarce, the same bridging relation can become a bottleneck or gatekeeping position. Where alternatives are plentiful, bridge failure may be absorbed through substitution. The analysis should therefore examine redundancy, switching conditions, legitimacy, capacity, and the consequences of bridge removal when interpreting positional importance.

Proposition 12.145 (Conditional bridge significance). *The economic significance of a bridging position depends on the mechanisms it enables and on the availability, cost, and timing of alternative pathways. Bridging status alone does not establish indispensability.*

12.25.5 Relational Bottlenecks

A relational bottleneck occurs where the capacity of an economically relevant process is constrained disproportionately by a limited passage, interface, decision point, resource, or coordinating position. Bottlenecks can be material, infrastructural, informational, legal, administrative, organizational, or epistemic. They can therefore appear in a network representation without being reducible to graph structure.

The same configuration may contain different bottlenecks for different processes. A supply network can have ample physical transport capacity while facing certification delays; a financing system can possess liquidity while lacking underwriting capacity; an organization can possess information while concentrating decision rights in a slow approval channel. Identifying a bottleneck therefore requires specifying the relevant flow or action process and the constraint that limits it.

Bottlenecks can also be endogenous. Growth in one capacity may shift pressure to another part of the architecture. Increased demand can transform a previously adequate interface into a limiting passage; automation of one task can reveal a complementary human or institutional constraint; diversification can reduce one bottleneck while creating coordination burdens elsewhere. Bottleneck analysis is consequently historical and revisable.

Remark 12.146 (Bottleneck attribution). A bottleneck is attributed relative to a process, scale, horizon, and set of feasible alternatives. The designation should be revised when those conditions change.

12.25.6 Peripheral Positions

Peripheral position refers to comparatively limited connection, reach, recognition, or proximity relative to a selected core, pathway, or relational configuration. Economic peripherality can concern markets, institutions, infrastructure, information, finance, authority, or knowledge. It is therefore multidimensional and cannot be inferred reliably from geographic distance alone.

Peripheral positions can face reduced access to information, finance, infrastructure, decision processes, or exchange opportunities. They can also retain forms of autonomy, specialization, local knowledge, lower exposure to some shocks, or access to resources unavailable to more central positions. The economic consequences of peripherality are thus configuration-specific.

Core and periphery can also be relationally co-produced. Concentration of standards, finance, logistics, information, or authority in one region of a system can increase the relative distance of other positions even when their own local characteristics remain unchanged. Conversely, new infrastructure, interoperability, institutional recognition, or knowledge links can alter peripherality without physically relocating the affected subjects.

Caution 12.147 (Peripherality and normative inference). Peripheral position is a structural description relative to a specified configuration. Its normative significance depends on the associated capacities, exposures, dependencies, values, and available alternatives.

12.25.7 Resource Fields

Field language becomes useful where resource conditions vary systematically with relational position. A *resource field* represents how the practical availability, cost, reliability, or convertibility of resources differs across positions in a specified economic configuration. The relevant position can be geographical, institutional, organizational, network-based, legal, or otherwise relational.

Resource fields are more informative than simple resource maps when the position-dependent condition itself affects action. Credit can be nominally available across a jurisdiction while financing terms vary with institutional recognition, collateral relations, information, or network position. Infrastructure can be physically present while service reliability differs across users. Knowledge, time, and administrative support can also be unevenly distributed through organizational or institutional structure.

A resource field should therefore specify at least the resource type, the positional coordinate or relational index being used, and the mechanism through which position affects effective resource conditions. Where these cannot be identified, ordinary distributional description may be clearer than field language.

Remark 12.148 (Resource-field restraint). A resource field is a representation of position-dependent resource conditions. It does not imply that the resource behaves as a physical field or that a continuous spatial formalism is required.

12.25.8 Capability Fields

A *capability field* represents variation in feasible action across relational positions. It builds on the distinction developed earlier between resources and capacities: two positions with similar nominal resources can possess different feasible action sets because access, institutional recognition, complementary resources, knowledge, timing, coordination, or social relations differ.

Capability fields can therefore reveal conversion structure that a resource distribution alone misses. The same educational credential can enable different occupational options across jurisdictions; the same financial asset can support different borrowing capacity depending on legal and institutional relations; the same information can have different practical value depending on authority, timing, and complementary expertise.

Capability-field analysis can be static for a limited question, but GRE generally treats capability as historically revisable. Learning, institutional change, infrastructure, relationship formation, or accumulated obligations can alter the field over time. Actions taken within the field can also reshape later capabilities, producing feedback between position, action, and future feasible sets.

Proposition 12.149 (Resource-field–capability-field non-equivalence). *Similarity in represented resource conditions does not imply similarity in represented capability conditions. The conversion of resources into feasible action depends on additional relational, institutional, epistemic, and temporal conditions.*

12.25.9 Knowledge and Trust Fields

Knowledge and trust can also vary systematically with relational position. A *knowledge field* represents position-dependent access to relevant information, expertise, interpretation, or learning opportunities. A *trust field* represents position-dependent expectations concerning reliability, cooperation, credibility, or acceptable vulnerability within specified relations. These representations can help explain why formally similar actors face different coordination conditions.

Knowledge fields are shaped by information channels, organizational membership, professional communities, infrastructures, language, institutional classification, secrecy, and histories of participation. Trust fields can reflect repeated interaction, reputation, common institutions, recognized credentials, shared practices, and histories of fulfilled or violated commitments. Embeddedness research provides established reasons to analyze economic action within ongoing relational structures (Granovetter 1985; Powell 1990).

Knowledge and trust remain analytically distinct. Access to accurate information does not guarantee trust; trust can persist where information is incomplete; and high trust can sometimes reduce scrutiny or amplify correlated error. Field representations should therefore specify the underlying relation and avoid treating either knowledge or trust as a homogeneous scalar substance.

Caution 12.150 (Knowledge and trust field interpretation). Field language should preserve the mechanisms through which knowledge or trust varies across positions. A visually smooth field representation can conceal discontinuities, contested interpretations, heterogeneous trust relations, and institutional boundaries.

12.25.10 Field Transformation

Economic topologies and fields can change through relation formation and dissolution, institutional reform, infrastructure, technological change, migration, organizational reconfiguration, learning, shocks, regulation, platform redesign, or shifts in standards and classification. Transformation may alter positions, pathways, distances, clusters, bridges, bottlenecks, and the distribution of effective resources or capabilities.

Some transformations are endogenous to the represented field. New connectivity can change incentives to form further ties; central positions can accumulate additional relations; congestion can redirect flows; institutional recognition can relocate access; and repeated action can change trust or knowledge distributions. Adaptive-network research provides one formal example of this general possibility by studying systems in which network structure and node dynamics coevolve (Gross and Blasius 2008). GRE uses the broader insight without assuming that every economic topology should be represented through an adaptive-network model.

Transformation also changes the validity of prior representations. A centrality estimate, identified bottleneck, cluster boundary, or field gradient can become obsolete when the relational configuration changes. Topological and field analysis therefore requires temporal provenance where earlier representations have influenced consequential decisions.

Proposition 12.151 (Configuration-dependent topological description). *A topological or field description of an economic configuration is valid only relative to the represented relations, boundaries, scale, time, and mechanism. Material change in those conditions can warrant revision of both the empirical representation and the economic interpretation attached to it.*

Remark 12.152 (Representational plurality). Topology and field language constitute one family of representations within GRE. Where a simpler institutional, historical, qualitative, accounting, contractual, or event-based description better answers the economic question, the more elaborate spatial or network representation should not be preferred merely for formal sophistication.

12.26 Multiscale and Historical Architecture

Economic architecture is simultaneously organized across several scales and carried through historical time. This section develops a multiscale and historical description of economic systems that complements the relational, institutional, topological, and field representations developed elsewhere in the chapter. Its objective is to clarify how configurations formed at one scale can condition processes at another, how economic structures acquire and reproduce relative stability, and how crisis, reorganization, dissolution, path dependence, and emergence can alter the architecture through which later economic action becomes possible. The argument is analytical and historical rather than teleological: scales are selected relative to the process under study, historical continuity is treated as an empirical question, and no universal sequence of development is assumed.

The present framework also avoids treating “micro,” “meso,” and “macro” as fixed ontological layers. Individuals, households, organizations, institutions, markets, in-

Table 12.28: Selected dimensions of multiscale and historical economic architecture

Dimension	Analytical object	Scope discipline
Scale plurality	Relations and processes represented at different resolutions	Scales are problem-relative rather than fixed ontological levels
Cross-scale coupling	Mechanisms by which changes at one scale condition another	Aggregation, mediation, timing, and feedback require explicit specification
Formation	Assembly of relations, rules, capacities, and boundaries	Formation need not imply deliberate design or a single origin
Stabilization	Conditions sustaining relative continuity	Stability is dimension- and horizon-relative
Reproduction	Recurrent enactment of architecture through time	Reproduction can include variation, learning, and reinterpretation
Crisis	Disruption of established coordination, expectations, or viability	Crisis labels require identified mechanisms and relevant base-lines
Reorganization	Recomposition of relations, roles, institutions, or scales	Reorganization can preserve some continuities while transforming others
Dissolution	Loss of sufficient coherence for a selected entity or configuration	Residual relations and obligations may survive dissolution
Path dependence	Historical sequencing that conditions later feasible alternatives	Persistence should be traced to specified mechanisms
Emergence	Appearance of economically consequential forms not captured by prior categories	Novelty remains scale-, description-, and evidence-dependent

frastructures, jurisdictions, transnational networks, and other configurations can become analytically relevant at different resolutions. Their relations can be nested, overlapping, or cross-cutting, and processes that appear aggregate at one scale can depend on heterogeneous lower-scale relations that aggregation conceals. Multiscale analysis is therefore justified where changing analytical resolution reveals mechanisms, constraints, capacities, or feedback that a single-scale description would miss. Explicit multiscale approaches in complexity research offer one family of representations for such questions, while GRE retains freedom to use historical, institutional, qualitative, network, or formal methods according to the problem (Bar-Yam 2004).

Definition 12.153 (Multiscale economic architecture). *A multiscale economic architecture is a historically situated configuration in which economically consequential relations, entities, institutions, capacities, constraints, and processes are represented at more than one analytically relevant scale, together with the mechanisms through which conditions at those scales interact.*

Table 12.28 summarizes the principal dimensions developed in this section. The entries are analytical prompts rather than an exhaustive taxonomy or a mandatory sequence of economic change.

12.26.1 Plural Scales of Economic Architecture

Economic processes can be represented at scales ranging from individual actions and household relations to organizations, industries, infrastructures, institutional systems, national economies, transnational production networks, and global financial or informational arrangements. These scales are not simply larger containers surrounding smaller ones. Each scale can select different relations, boundaries, time horizons, and mechanisms as analytically salient.

A household-level analysis can reveal care obligations, intrahousehold allocation, or dependency that disappear in national aggregates. An organizational analysis can reveal authority, coordination, and knowledge pathways concealed by sector-level statistics. A transnational analysis can reveal supply, ownership, financing, regulatory, or infrastructural relations that jurisdiction-specific descriptions divide into separate units. Conversely, highly aggregated analysis can disclose system-wide constraints or coordination patterns that cannot be inferred from one local case alone.

The choice of scale therefore carries epistemic consequences. Aggregation can stabilize measurement and make broad comparison possible while compressing heterogeneity. Fine-grained analysis can retain local relational structure while making system-level pattern more difficult to identify. Neither resolution is intrinsically superior. GRE treats scale selection as part of the representation problem and asks what causal, institutional, distributional, or historical content becomes visible or hidden at the selected resolution.

Remark 12.154 (Scale-relative representation). A subject, entity, relation, constraint, or capacity can change analytical status when the scale of representation changes. Scale change therefore warrants renewed examination of what has been aggregated, decomposed, or treated as exogenous.

12.26.2 Cross-Scale Coupling

Multiscale analysis becomes especially important where processes at different scales are coupled. Local decisions can accumulate into aggregate demand, organizational routines can shape sectoral standards, national regulation can alter household or firm-level feasible action, and transnational infrastructures can condition the effectiveness of domestic policy. Causation can operate in several directions and can involve mediation, delay, threshold effects, or feedback.

Cross-scale coupling should therefore be specified through mechanisms rather than inferred from simultaneous change. A macroeconomic shift may affect subjects through prices, employment, credit, taxation, public provision, expectations, or institutional responses. Local innovations may become systemically consequential only after standardization, diffusion, financing, regulatory recognition, or network expansion. Intermediate organizations and institutions frequently mediate such translation.

Temporal scale also matters. Transactions and expectations can change rapidly, while legal structures, productive capabilities, infrastructures, trust relations, and organizational routines may change more slowly. The relative pace of these processes can affect whether coordination remains viable. Fast-slow language can be useful where distinct characteristic timescales are empirically defensible, but GRE treats scale separation as a hypothesis rather than a default description. During substan-

tial transitions, previously separable dynamics can become tightly coupled.

Proposition 12.155 (Cross-scale attribution). *An observed association between changes at different economic scales supports a cross-scale explanation only to the extent that the analysis identifies plausible transmission, mediation, aggregation, or feedback mechanisms connecting the represented processes.*

12.26.3 Economic Formation Processes

Economic architecture forms through the establishment and recombination of relations, boundaries, roles, routines, institutions, infrastructures, representations, and capacities. Formation can be deliberate, incremental, negotiated, conflictual, imitative, technologically mediated, or partly unintended. The relevant history often contains several sources rather than a single founding event.

Formation is therefore better analyzed as a process than as a date. A market can form through repeated exchange, standards, legal recognition, information systems, specialized intermediaries, and expectations of continued participation. An organization can form through role differentiation, authority, coordination, memory, and resource commitments. A platform or infrastructure can acquire economic significance as downstream actors reorganize activity around its interfaces. Institutional formation can proceed through formal rule creation as well as repeated practice and shared expectations.

Historical inquiry matters because different formation paths can produce configurations with similar present manifestations but different dependencies, obligations, memories, and capacities for change. Economic-historical and institutional traditions offer several ways of analyzing such processes, including accounts of the historical construction of market society and the role of institutions in shaping long-run interaction (Polanyi 1944; North 1990).

Remark 12.156 (Plural origins). Economic formation need not possess a singular origin. Where several processes jointly contribute to a later configuration, assigning one event as “the” origin can conceal the relational and historical conditions that made the configuration possible.

12.26.4 Architectural Stabilization

An economic configuration becomes relatively stabilized when selected relations, expectations, roles, routines, boundaries, or capacities persist sufficiently to support recurrent action and recognizable continuity. Stabilization can arise through contracts, law, standards, infrastructure, habits, organizational memory, shared expectations, sunk investments, technical compatibility, repeated coordination, or mutually reinforcing dependencies.

Stabilization is dimension-relative. Prices can remain volatile while ownership relations remain stable; organizational membership can change while routines persist; formal law can remain unchanged while administrative interpretation shifts. An architecture can therefore be stable along some dimensions and unstable along others. The relevant dimension and horizon should be stated rather than inferred from the word “stability” alone.

Stabilization can also be endogenous. Repeated use can increase familiarity, com-

plementary investment, network density, or institutional support, thereby making continued use easier. Such mechanisms can generate persistence without implying optimality or desirability. Institutional analysis and increasing-return accounts provide established examples of mechanisms through which earlier arrangements can shape later possibilities (North 1990; Arthur 1989).

Proposition 12.157 (Dimension-relative stabilization). *The stabilization of an economic architecture should be attributed to specified dimensions, mechanisms, and time horizons. Persistence in one dimension does not establish general stability of the configuration.*

12.26.5 Historical Reproduction

Economic architecture persists through recurrent enactment. Contracts are renewed or replaced, rules are interpreted, organizational routines are performed, infrastructure is maintained, classifications are applied, skills are reproduced, expectations are updated, and participants enter or leave. Reproduction therefore differs from passive persistence: continuity commonly depends on repeated activity and resource commitments.

Reproduction can include variation. Each enactment occurs under current conditions and can modify the architecture it reproduces. Administrative implementation can reinterpret a rule, routine performance can generate learning, market participation can change expectations, and intergenerational transmission can alter the meaning or usability of inherited resources. Evolutionary economics has long emphasized routines, search, selection, and changing firm behavior as mechanisms of economic continuity and change (Nelson and Winter 1982).

Reproduction is also distributed across scales. Household practices can reproduce labor capacities; organizations can reproduce occupational roles and technical routines; institutions can reproduce classifications and rights; infrastructures can reproduce pathways of access and dependence. The architecture that appears stable at a higher scale may therefore depend on extensive lower-scale work that aggregate description does not display.

Remark 12.158 (Reproduction with variation). Historical reproduction in GRE permits modification, reinterpretation, and selective retention. Continuity should therefore be distinguished from exact replication.

12.26.6 Crisis and Architectural Disruption

A crisis can be represented as a period in which established relations, expectations, coordination mechanisms, access conditions, or institutional capacities become insufficiently reliable for activities that previously depended on them. The term should be used with care because disruption can be localized, sectoral, organizational, institutional, financial, ecological, or system-wide, and the same event can have very different consequences across positions.

Crisis analysis should identify the affected architecture and the mechanism of disruption. Relevant mechanisms can include liquidity breakdown, infrastructure failure, loss of trust, coordination failure, legal discontinuity, supply interruption, rapid repricing, institutional overload, conflict, or coupled failures across several domains.

Some crises involve abrupt shocks; others become visible only after slow accumulation of vulnerability.

The concept also requires a baseline. A configuration can be experienced as crisis by some subjects while remaining functional or even advantageous for others. Declaring a crisis therefore does not substitute for analysis of affected capacities, exposures, distributions, and time horizons. Where critical-transition models are invoked, their assumptions and empirical indicators require separate justification; crisis and criticality should not be treated as synonyms.

Caution 12.159 (Crisis attribution). The label *crisis* should identify the configuration, functions, capacities, or relations whose continuity has become materially disrupted. It should not be used as a general intensifier for economic change.

12.26.7 Economic Reorganization

Economic reorganization occurs when relations, roles, boundaries, institutions, technologies, infrastructures, ownership structures, or coordination mechanisms are re-composed in ways that alter how the architecture operates. Reorganization can follow crisis, but it can also arise through innovation, policy change, organizational learning, demographic change, new standards, shifting expectations, or gradual accumulation.

Reorganization can preserve substantial continuity. A firm can reorganize authority while retaining legal identity; a market can reorganize around new intermediaries while many participants remain; an institution can alter administrative procedures while formal legislation remains stable. Conversely, apparently modest changes in standards, classifications, or interfaces can reorganize access and dependency across an entire field.

The relevant analytical question is therefore what relational architecture changed and what remained continuous. Schumpeterian analysis of innovation and later evolutionary work on technological trajectories and institutional coevolution provide influential accounts of economic change in which new combinations and evolving technical-institutional structures reorganize production and competition (Schumpeter 1934; Dosi 1982; Nelson 1994).

Proposition 12.160 (Reorganization with selective continuity). *Economic reorganization can transform the operating structure of a configuration while preserving selected entities, relations, institutions, or historical obligations. The extent of reorganization is therefore dimension-specific.*

12.26.8 Architectural Dissolution

An economic architecture can lose sufficient coherence that it no longer functions as the configuration previously identified. Dissolution can occur through organizational closure, relation termination, institutional abandonment, technological obsolescence, fragmentation, loss of membership, infrastructure withdrawal, legal change, conflict, or gradual disappearance of the practices that sustained the architecture.

Dissolution should be distinguished from instantaneous disappearance. Assets, liabilities, knowledge, environmental effects, contractual claims, reputations, social obligations, data, standards, and infrastructures can survive the configuration that generated them. Participants can also carry learned routines, expectations, and de-

dependencies into later arrangements. The historical consequences of a dissolved architecture can therefore continue to shape subsequent economic fields.

The threshold at which dissolution is attributed depends on the analytical object. A corporation can dissolve legally while an operational network persists; a market category can disappear while exchange relations continue under another classification; an institution can lose formal recognition while informal practices remain. Dissolution, like entityhood, is consequently a revisable attribution relative to specified dimensions.

Remark 12.161 (Residual architecture). The dissolution of an economic configuration need not dissolve the relations, obligations, capacities, or material consequences produced during its history. Residual structure can become part of the conditions under which later architectures form.

12.26.9 Path-Dependent Architecture

Path dependence concerns cases in which the sequence of earlier events materially conditions later feasible alternatives, costs, expectations, or probabilities of continuation. The concept is useful when historical order contributes explanatory content beyond current-state variables alone. Economic applications have emphasized mechanisms including increasing returns, technical interrelatedness, learning, coordination effects, quasi-irreversibility, and institutional self-reinforcement (David 1985; Arthur 1989; Pierson 2000).

GRE treats path dependence as mechanism-specific. Historical persistence can arise from several processes, and not every durable configuration is path dependent in the same sense. A researcher should therefore identify what earlier event or sequence altered later possibilities and through which mechanism the effect persists. The analysis should also retain the possibility of branching, recombination, and later transformation.

Path dependence can operate across scales. Household wealth, organizational routines, technological standards, legal classifications, infrastructure placement, and transnational production arrangements can each create inherited conditions that affect later options. Cross-scale feedback can reinforce or weaken these effects. Early local choices can acquire wider significance through diffusion or standardization, while system-level change can reopen alternatives that appeared locally locked in.

Proposition 12.162 (Mechanism-specific path dependence). *A claim of economic path dependence should identify the historical sequence and the mechanism through which that sequence changes later feasible alternatives, costs, capacities, or transition conditions. Persistence alone is insufficient to establish path dependence.*

12.26.10 Emergence of New Economic Forms

Economic history can generate configurations for which inherited categories provide only partial description. New organizational forms, technologies, transaction architectures, property arrangements, infrastructures, labor configurations, financial instruments, communities, or combinations of these can create relations and capacities that were previously absent or analytically negligible. Complexity and evolutionary perspectives have offered several ways of studying novelty arising through heterogeneous adaptation, innovation, and interaction (Arthur 1999; Nelson and Winter 1982).

Emergence should nevertheless be claimed cautiously. A configuration can appear new because the observer changed scale, classification, or measurement rather than because the underlying economic relations changed substantially. Conversely, a familiar label can conceal a relationally novel architecture. Claims of novelty therefore require comparison of mechanisms, positions, capacities, boundaries, and histories rather than reliance on naming alone.

New forms can also reorganize the scales at which economic activity becomes intelligible. A platform can connect local exchange to transnational infrastructure; a new legal form can coordinate dispersed ownership; a technical standard can create a field spanning several industries; an institutional innovation can alter the relation between household, organization, and state. The emergence of form and the emergence of analytical scale can therefore be intertwined.

Remark 12.163 (Emergence and evaluation). The emergence of a new economic form establishes neither novelty's desirability nor its durability. New configurations can expand capacities and options while also generating dependencies, exclusions, fragilities, or constraints. Their normative and practical evaluation requires additional argument.

Multiscale and historical architecture thus provides a way to describe economic systems as temporally evolving configurations whose relevant scales, boundaries, and mechanisms can themselves change. The representation remains provisional: a scale that is adequate for one historical question can be misleading for another, and a model that captures stabilization can become inappropriate during substantial reorganization. GRE therefore treats scale and history as dimensions of the economic object rather than as background variables appended after a static architecture has already been defined.

12.27 Generative Potential of Economic Architecture

Economic architecture matters not only through its present distributions, organizations, institutions, relations, and constraints, but also through the range of later configurations that it makes more or less accessible. This section develops *generative potential* as a provisional analytical language for studying those future-shaping properties. Its objective is to distinguish the generation of relations, capabilities, knowledge, participation, options, constraints, and dependence; to examine self-reinforcing, differentiated, and fragile generative structures; and to clarify how economic architecture can alter transition possibilities and the relative accessibility of alternative histories. The method is relational, historical, and mechanism-oriented. Generative potential is treated as conditional on specified subjects, scales, histories, and horizons rather than as a universal scalar property of an economy.

The term *potential* requires particular restraint. It does not denote an outcome that will necessarily occur, and it need not denote an objective probability. It also differs from capacity. A capacity concerns what a subject or configuration can effectively do under specified conditions; generative potential concerns how an architecture conditions the formation of later relations, capacities, options, constraints, dependencies, and transition paths. A configuration can therefore contain substantial generative potential that remains unrealized, while a realized change can arise from a comparatively narrow potential when a particular event, intervention, or disturbance selects

one path among many.

The adjective *generative* is likewise descriptive before it is normative. Economic architecture can generate cooperation, knowledge, productive capacity, participation, and new options. It can also generate exclusion, constraint, dependence, concentration, vulnerability, and reduced alternatives. The existence or magnitude of generative potential therefore establishes neither desirability nor justice. Those evaluations require additional normative and empirical argument.

Definition 12.164 (Generative potential of economic architecture). The *generative potential of an economic architecture* is the historically situated and relation-dependent capacity of that architecture to make specified future relations, capabilities, knowledge states, participation forms, options, constraints, dependencies, or transitions more or less accessible over a stated scale and horizon. The concept does not require a single metric, probability distribution, or normative ranking.

Table 12.29 summarizes the principal dimensions considered in this section. The list is illustrative rather than exhaustive. Additional forms of generative potential may become relevant as economic arrangements, technologies, institutions, and forms of agency change.

Proposition 12.165 (Potential–realization non-equivalence). *An economic architecture can make a future configuration comparatively accessible without that configuration being realized. Realization depends on subsequent events, choices, interventions, disturbances, interpretations, and interactions that are not exhausted by the architecture’s prior generative potential.*

12.27.1 Generation of Relations

Economic architecture can condition which relations become possible, recurrent, costly, prohibited, attractive, or institutionally recognizable. Property rules can enable some contractual relations while excluding others. Infrastructures can make recurrent exchange or coordination possible across distance. Organizational routines can create durable authority and knowledge relations. Standards can make previously disconnected systems interoperable. Platforms can establish recurrent mediation among actors who would otherwise interact only intermittently or through different intermediaries.

Relation generation does not require deliberate design. Repeated interaction can produce trust, dependence, conventions, reputational relations, or informal obligations that were not specified in advance. Conversely, deliberate institutional design can fail to generate the relation it was intended to create if complementary capacities, expectations, or enforcement conditions are absent. The relevant question is therefore not whether a formal opportunity for relation exists, but which mechanisms make relation formation practically accessible and reproducible.

New relations can also alter the architecture that generated them. A newly formed supplier relation can create specialized investment; specialized investment can deepen dependence; dependence can affect bargaining, information sharing, and later contracting. Relation generation is consequently recursive. The architecture conditions relation formation, and newly formed relations can become part of the architecture conditioning subsequent relations.

Remark 12.166 (Relational generation and persistence). A relation’s generation and

Table 12.29: Selected dimensions of generative potential in economic architecture

Dimension	Analytical question	Scope discipline
Relation generation	Which new or transformed relations become feasible or recurrent?	Relation formation requires identified mechanisms and participants
Capability generation	Which effective abilities can later be formed or expanded?	Resources and nominal access do not by themselves establish capability
Knowledge generation	Which processes create, retain, interpret, or distribute usable knowledge?	Information production and knowledge formation remain distinct
Participation generation	Which forms of contribution, representation, access, or influence become possible?	Participation depth and distribution require separate analysis
Option generation	Which later courses of action become feasible, affordable, or institutionally available?	Option counts alone do not establish practical value
Constraint generation	Which later restrictions, obligations, bottlenecks, or exclusions are produced?	Constraints are position-, process-, and horizon-relative
Dependence generation	Which capacities become reliant on actors, resources, infrastructures, or permissions elsewhere?	Dependence is dimension-specific and need not imply domination
Self-reinforcement	Which feedbacks increase the persistence or reproduction of a configuration?	Persistence should be traced to mechanism rather than inferred from duration alone
Differentiated potential	How is future-generating capacity distributed across positions and scales?	Difference does not by itself establish normative ranking
Fragility	Which generative capacities depend on narrow supporting conditions or vulnerable complementarities?	Fragility is relative to disturbance, horizon, and recovery possibilities
Transition potential	Which configurations or histories become more or less accessible as the architecture changes?	History weights require explicit interpretation and need not be probabilities

its later persistence are distinct analytical questions. Conditions sufficient for initial formation may differ from those that reproduce, deepen, transform, or dissolve the relation over time.

12.27.2 Generation of Capabilities

Economic architectures can generate capabilities by combining resources, access, knowledge, coordination, institutions, infrastructures, and complementary relations in ways that make previously unavailable action feasible. A training system can convert time, instruction, institutional recognition, and practice into later professional capability. A transport or digital infrastructure can expand the practical reach of existing resources. An organization can combine differentiated expertise into capacities unavailable to any individual member. A public institution can make a

legal entitlement operational through administrative procedures, information, and implementation capacity.

Capability generation should not be inferred directly from resource accumulation. Section 12.17 established resource–capacity non-equivalence: effective capacity depends on conversion conditions and relational position. The same point extends dynamically. An architecture can possess resources yet have weak capability-generating potential when access, coordination, learning, or complementary conditions are missing. Conversely, modest resources can sometimes support substantial capability formation when institutional and relational complementarities are strong.

Capability-oriented economic analysis has long emphasized the distinction between resources and effective opportunities (Sen 1999). GRE extends that distinction historically by asking how architectures participate in the formation, maintenance, erosion, and redistribution of capabilities through time. The resulting potential can be collective as well as individual. Organizational routines, shared infrastructures, public institutions, communities of practice, and interoperable standards can generate capacities located partly in relations among participants rather than in any one actor.

Proposition 12.167 (Architecture-relative capability generation). *The capability-generating potential of an economic architecture depends on the mechanisms through which resources, access, knowledge, coordination, and complementary relations become usable together. Resource quantity alone is insufficient to determine that potential.*

12.27.3 Generation of Knowledge

Economic architecture can generate knowledge through observation, experimentation, production, exchange, repeated interaction, record keeping, comparison, classification, scientific inquiry, professional practice, and organizational learning. The knowledge produced can concern technologies, demand, costs, institutions, other participants, ecological conditions, risks, or the operation of the architecture itself.

Knowledge generation is distributed. Hayek’s analysis of dispersed knowledge remains relevant to the difficulty of aggregating context-specific information into one decision center (Hayek 1945). Organizations and institutions can nevertheless create mechanisms for retaining, interpreting, and transmitting knowledge across time. Routines, databases, standards, professional communities, records, models, and embodied expertise can each participate in that process. Evolutionary accounts of firms likewise emphasize routines, search, and learning as mechanisms through which economic behavior changes historically (Nelson and Winter 1982).

The architecture that generates knowledge can also shape what becomes knowable. Classification systems define categories of observation; accounting systems establish units of comparison; incentives affect what participants report; infrastructures determine what can be measured; authority structures influence which observations receive attention. Knowledge generation therefore includes epistemic selectivity. An architecture can improve knowledge in one dimension while making other dimensions less visible.

Generated knowledge can in turn alter economic relations. A forecast can change investment; a classification can change eligibility; an audit can alter organizational behavior; a technical discovery can reorganize production. Knowledge generation

therefore interacts with the performative and epistemic-event architecture developed in Section 12.24. The relevant analysis should distinguish production of a representation from the later consequences produced through its uptake.

12.27.4 Generation of Participation

Economic architecture can generate participation by creating roles, memberships, access pathways, contribution opportunities, representational channels, and decision interfaces. Education can make occupational participation possible; infrastructure can enable participation at distance; institutional recognition can make a group eligible for programs or governance processes; organizational design can create new roles through which participants contribute knowledge or labor.

Participation generation is multidimensional. Entry into a market does not guarantee influence over its rules. Organizational membership does not ensure access to strategic decisions. Digital connectivity does not ensure visibility. Formal citizenship or legal status does not guarantee procedural usability of institutions. The relevant potential therefore concerns the kinds and depth of participation that become practically available to particular positions.

Participation can also reshape the subjects who participate. Repeated work can generate skill and professional identity; collective governance can generate procedural knowledge and trust; participation in credit, insurance, or platform systems can create records that affect later eligibility. These effects can expand later options while also producing new obligations, monitoring, dependency, or exposure. The generative potential of participation thus includes the production of future positions, not merely the immediate opportunity to take part.

Remark 12.168 (Participation as generated position). A participation opportunity can be economically consequential even when immediate material transfer is small, because participation may alter knowledge, recognition, reputation, obligations, network position, or later access. These consequences require empirical specification rather than automatic attribution.

12.27.5 Generation of Options

Economic architecture can alter the set of later actions that are practically available. Savings can create waiting capacity; interoperable standards can make switching feasible; education can open occupational alternatives; public infrastructure can expand geographic reach; legal forms can enable new modes of association; insurance can make otherwise prohibitive risks bearable. In this sense, some architecture is option-generating.

An option should be distinguished from a merely imaginable alternative. Practical options depend on resources, access, permissions, timing, information, capabilities, and complementary relations. They can also expire. A financing opportunity available before a deadline, a labor-market option dependent on a credential, or an exit route dependent on interoperability may disappear as conditions change. Option generation is therefore historical and time-sensitive.

A larger option set does not automatically imply a better practical condition. Options can impose cognitive burden, generate strategic uncertainty, or be irrelevant to the subject's aims. Some forms of commitment deliberately close options in order to

enable cooperation, investment, trust, or specialization. GRE therefore treats option generation as one analytical dimension among others, not as a universal objective.

The practical importance of options becomes especially visible under uncertainty. Architectures that preserve several feasible pathways can permit later adaptation as knowledge changes, while highly specialized architectures can concentrate capability around fewer paths. Whether such concentration is advantageous depends on expected benefits, reversibility, disturbance, coordination requirements, and the values at stake.

12.27.6 Generation of Constraints

Generative architecture can produce constraints as well as options. Investment can create sunk commitments. Standards can narrow compatible technologies. Organizational specialization can reduce substitutability. Legal arrangements can create obligations and restrictions. Infrastructures can orient activity around particular routes or interfaces. Classification systems can exclude positions that do not fit established categories. The production of constraint is therefore part of generative analysis rather than an exception to it.

Generated constraints can be enabling. A common standard can restrict design freedom while making interoperability possible. Contractual commitment can reduce unilateral discretion while enabling coordinated investment. Professional rules can restrict practice while supporting trust and shared expectations. The analytical task is to identify which capacities a constraint enables, which it restricts, for whom, and over what horizon.

Constraint generation can also be cumulative. A series of individually modest commitments can produce a configuration that becomes costly to alter. Technical compatibility, contractual obligations, organizational routines, reputational expectations, and infrastructure can reinforce one another. Historical analysis is needed to distinguish such cumulative constraint from an intrinsic impossibility.

Proposition 12.169 (Generative constraint formation). *An economic architecture can expand selected capacities while simultaneously generating constraints on other actions or later transitions. Generative analysis should therefore track capability formation and constraint formation together rather than treating them as opposing processes.*

12.27.7 Generation of Dependence

Architectures that expand capacity often do so through specialization and complementarity. These same processes can generate dependence. A firm can gain productive capacity by relying on a specialized supplier; a household can gain access through a platform while becoming dependent on its interface; an organization can benefit from expert knowledge while losing internal capability to evaluate it; a jurisdiction can gain efficiency through shared infrastructure while becoming exposed to disruptions elsewhere.

Dependence generation therefore should not be treated as evidence that the underlying architecture has failed. Mutual dependence can enable coordination and collective capacity. The analytical question concerns the dimensions, alternatives, substitutability, exit conditions, and distribution of the dependence. Dependence becomes

especially consequential where access to a necessary complement is concentrated, difficult to replace, or governed by rules that participants cannot readily influence.

Generated dependence can also alter future bargaining and knowledge. Specialized investment can reduce exit options. Repeated delegation can erode internal expertise. Reliance on one classification or standard can make later migration costly. These processes can create feedback through which earlier capacity-enhancing choices change later relational positions.

Remark 12.170 (Capacity–dependence coupling). The same architectural relation can generate capacity and dependence simultaneously. Assessment therefore requires dimension-specific analysis of what is gained, what becomes reliant on external conditions, and which alternatives remain practically available.

12.27.8 Self-Reinforcing Generative Structures

Some generative processes alter the conditions of their own continuation. Learning can reduce later production costs; wider adoption can increase the usefulness of a standard; organizational routines can make repeated coordination easier; accumulated records can improve later prediction; reputation can attract additional partners; institutional familiarity can reduce transaction or compliance costs. Under such conditions, the realized history can increase the accessibility of related later histories.

Increasing-return and path-dependence literatures provide well-known formal and historical examples of self-reinforcement. Arthur shows how increasing returns can make early adoption events consequential for later technological selection, while Pierson emphasizes how increasing-return mechanisms can magnify timing and sequence in institutional development (Arthur 1989; Pierson 2000). GRE uses these mechanisms as examples rather than as a universal account of generativity.

Self-reinforcement should be distinguished from simple persistence. A configuration can persist because external conditions remain stable without becoming increasingly self-supporting. Conversely, a self-reinforcing process can eventually encounter countervailing constraints, saturation, institutional change, technical substitution, or political opposition. Claims of self-reinforcement therefore require identification of the feedback through which prior realization alters later continuation conditions.

Self-reinforcement can operate across different generative dimensions. Capability can generate knowledge; knowledge can improve coordination; coordination can attract participation; participation can expand a network; network expansion can improve access to resources. A reinforcing configuration can therefore involve several coupled processes rather than one homogeneous feedback loop.

Proposition 12.171 (Mechanism-specific self-reinforcement). *A claim that economic architecture is self-reinforcing should identify the mechanism through which earlier realization changes the conditions of later reproduction or expansion. Persistence, growth, or repeated observation alone does not establish self-reinforcement.*

12.27.9 Differentiated Generative Potential

Generative potential can be distributed unevenly across subjects, positions, organizations, places, and scales. The same infrastructure can expand options for one group while offering limited usability to another. A financial arrangement can provide one

actor with investment capacity while placing another in a dependent creditor–debtor relation. A knowledge system can make some participants better able to classify, predict, or redesign the field than others. These differences concern the distribution of future-generating positions rather than only the distribution of current stocks.

Differentiated generative potential is not reducible to the economic asymmetries described in Section 12.23. A present resource or capability asymmetry can contribute to later generative difference, but generative potential also depends on conversion pathways, institutional recognition, topology, time horizons, option structure, and the capacity to alter rules or infrastructures. Two subjects with comparable present resources can therefore possess different capacities to shape future relations.

The concept also requires restraint. Greater generative potential in one dimension does not establish a general ranking of persons or organizations, and unequal generative potential does not by itself establish injustice. Normative analysis requires additional claims about rights, welfare, responsibility, legitimacy, distribution, and affected interests. The descriptive contribution is to identify where the architecture gives different positions different capacities to produce or redirect later economic possibilities.

Proposition 12.172 (Position-relative generative potential). *The generative potential of an economic architecture can differ across relational positions even when those positions participate in the same formal institution, market, organization, or infrastructure. Attribution should therefore identify the subject, dimension, horizon, and mechanism to which the potential refers.*

12.27.10 Generative Fragility

An architecture can possess substantial generative potential while depending on a narrow set of supporting conditions. This condition can be described as *generative fragility*: the production of valued or economically consequential capacities, relations, or options depends strongly on components, complementarities, expectations, or pathways that are vulnerable to disruption.

Fragility is relative to disturbance. A supply architecture can be robust to ordinary demand variation while fragile to the loss of one specialized input. A knowledge system can be robust to personnel turnover while fragile to the disappearance of a particular archive or interface. A platform can sustain many users while remaining dependent on a small number of infrastructural services. No architecture is simply fragile in the abstract; the analysis should identify the disturbance, affected generative function, recovery mechanism, and horizon.

Generative fragility can arise from concentration, tight coupling, low substitutability, temporal synchronization, hidden dependencies, insufficient redundancy, or reliance on tacit knowledge concentrated in few positions. It can also arise from successful specialization. An arrangement optimized around a narrow set of conditions may generate exceptional capacity while those conditions hold and adapt poorly when they change.

The relation between fragility and evaluation remains context-dependent. Redundancy can preserve capacity under disturbance while imposing cost. Tight coordination can increase efficiency while reducing flexibility. Specialization can generate knowledge while narrowing alternatives. GRE therefore treats generative fragility as a property to be investigated rather than a universal reason to favor one architecture

over another.

Definition 12.173 (Generative fragility). *Generative fragility* is the sensitivity of an architecture's specified capacity to generate relations, capabilities, knowledge, participation, options, or other economically consequential forms to disruption of the supporting conditions on which that generative process depends.

12.27.11 Transition Potentials and Historical Reweighting

Generative potential becomes especially significant when economic architecture is represented through alternative possible histories. Resources, institutions, topology, expectations, dependencies, constraints, and accumulated history can make some transitions comparatively accessible and others comparatively difficult. *Transition potential* denotes these architecture-relative conditions affecting which later configurations can plausibly be reached and through which paths.

Transition potential need not be a physical potential function or an objective probability. A formal model may assign probabilities, propensities, costs, feasibility scores, or other weights to alternative histories; qualitative analysis may reconstruct relative accessibility through institutional barriers, historical precedents, path dependence, actor capacities, or scenario comparison. The interpretation of a history weight should therefore be stated explicitly.

Events can reweight later possibilities. Law can enable previously unavailable organizational forms; technical change can alter path costs; crisis can unsettle established assumptions; epistemic events can change expectations or classifications; interventions can create new resources, dependencies, or constraints. Such changes may alter the relative accessibility of histories even when the set of imaginable futures remains similar.

Historical reweighting can also be asymmetric. An intervention can expand one actor's options while narrowing another's; a standard can facilitate one trajectory while increasing switching costs for alternatives; infrastructure can open one regional pathway while redirecting investment elsewhere. Cross-scale analysis is therefore relevant when local changes modify wider transition conditions or aggregate changes restructure local feasible histories.

Proposition 12.174 (Architecture-relative transition potential). *A claim that economic architecture favors, suppresses, or reweights a future history should identify the represented alternatives and the mechanisms changing their relative feasibility, cost, accessibility, propensity, or support. History weights need not be interpreted as objective probabilities unless the model warrants that interpretation.*

12.28 Allocation Interface of Economic Architecture

Chapter 12 closes by specifying the architectural information that later allocation analysis may need to inherit. Its role is deliberately limited. The preceding sections have established economic subjects, entities, relations, boundaries, institutions, resources, capacities, access conditions, control structures, dependencies, asymmetries, symbolic relations, topology, history, and generative potential. The present section identifies which of those distinctions become relevant when an inquiry turns to allocation. It does not yet construct a general theory of allocation, prescribe an allocation

mechanism, or supply an evaluative rule. Those tasks belong to Chapter 13.

Within the present chapter, allocation is therefore treated as an interface problem between an economic architecture and a later analysis of change within that architecture. A recipient-centered representation can remain sufficient where the relevant question concerns a clearly specified resource, a tractable recipient, and consequences adequately represented by receipt or holding. A richer representation becomes warranted when access, conversion conditions, relations, higher-order structures, scale, asymmetry, or later feasible action materially alter the meaning or incidence of the allocation.

Definition 12.175 (Allocation-relevant economic architecture). For a specified inquiry, an *allocation-relevant economic architecture* is the subset of economic objects, relations, boundaries, capacities, constraints, access conditions, control positions, scales, and historical dependencies whose configuration materially affects how an allocated resource or enabling condition can be received, used, converted, retained, or propagated. The relevant subset is question-relative and can remain small when additional architectural distinctions do not change the claim.

Definition 12.175 preserves the chapter's general proportionality rule. Architectural richness is justified by analytical consequence rather than by the availability of a larger vocabulary. Table 12.30 summarizes the principal information that can be handed forward to allocation analysis.

12.28.1 Allocated Objects and Conversion Conditions

The first requirement is to identify the allocated object at an analytically useful level. Material goods, money, time, information, infrastructure, legal rights, institutional access, technical capacity, attention, and control positions can all become economically consequential, yet their practical effects depend on different conditions. The architecture developed in Sections 12.16–12.19 therefore enters allocation analysis through the distinction among resource availability, practical access, usable capacity, and the constraints surrounding conversion from one to another.

A monetary transfer can be useful without additional modeling when money itself is the relevant outcome. The same transfer can require a richer account when its purpose is to generate access to housing, education, mobility, research capacity, health services, or organizational survival. In those cases, infrastructure, eligibility, complementary resources, timing, knowledge, or institutional recognition can condition whether the allocated means become effective. Chapter 12 contributes the architecture needed to state those conditions; Chapter 13 examines allocation processes through them.

12.28.2 Recipients, Boundaries, and Effective Incidence

Administrative systems usually require identifiable recipients or burden-bearing units. Persons, households, firms, organizations, public bodies, jurisdictions, and other accounting or legal units make payment, entitlement, audit, liability, and reporting possible. Their operational usefulness does not guarantee that economically consequential incidence ends at the same boundary.

An allocation to one household can affect internal bargaining, care, debt, employment, or dependence. Funding to an organization can affect workers, suppliers, users,

Table 12.30: Architectural information relevant to later allocation analysis

Architectural dimension	Question for the allocation interface	Reason for retaining it
Allocated object	What resource, right, access condition, enabling condition, or control position is relevant?	Heterogeneous objects can differ in transferability, usability, durability, and conversion requirements
Recipient and incidence	Which unit formally receives or bears the allocation, and where can consequential incidence occur?	Administrative receipt can differ from practical use, exposure, control, or downstream consequence
Conversion conditions	Which complementary capacities, permissions, infrastructures, knowledge, or relations affect effective use?	Nominal receipt does not necessarily imply practical accessibility or capability
Relational configuration	Which relations can be formed, altered, stabilized, weakened, or dissolved?	Allocation can change dependence, coordination, authority, cooperation, or exit conditions
Higher-order structure	Which organization, institution, commons, platform, infrastructure, or other configuration can be affected?	Some consequences depend on joint organization rather than separable recipient effects
Scale and boundary	At which scales and across which boundaries can effects become material?	Local receipt can have organizational, institutional, regional, transnational, or cross-scale incidence
Asymmetry and history	Which pre-existing differences and inherited conditions shape conversion or consequence?	Similar nominal allocations can operate differently across historically differentiated positions
Generative consequence	Which later capacities, constraints, dependencies, or practical possibilities can be altered?	Present allocation can change the conditions under which later economic action occurs

collaborators, and surrounding infrastructure. A rule applied to a platform can redistribute opportunities among users and complementors. These effects should be traced only where an identifiable pathway makes them material to the inquiry.

Proposition 12.176 (Recipient–incidence non-equivalence). *The formal recipient or burden-bearing unit of an allocation need not coincide with the position, relation, configuration, or scale at which its economically consequential incidence is realized. A wider architectural boundary is warranted when identifiable mechanisms make the difference material to explanation or evaluation.*

12.28.3 Relational and Higher-Order Consequences

The economic architecture also permits the consequences of allocation to be indexed to relations and higher-order configurations. Shared infrastructure, translation capacity, interoperability, collective insurance, commons governance, care arrangements, research collaboration, and cross-organizational coordination can have effects that depend on how several positions are connected. The administrative vehi-

cle can still be a conventional recipient; the analytical consequence can nevertheless concern the relation or configuration that the allocation helps to constitute.

This distinction remains conditional. A collection of recipient-level effects should not be redescribed as higher-order merely because several recipients are involved. Higher-order analysis becomes useful when joint organization, complementarity, common rules, or configuration-level properties contribute explanatory content that adequate decomposition would lose. Chapter 13 develops the corresponding allocation forms and their institutionalization.

12.28.4 Scale, Asymmetry, and Historical Dependence

Allocation enters an architecture already differentiated by scale, boundary, asymmetry, and history. The same formal resource can therefore have different consequences across positions with different access, information, bargaining capacity, institutional standing, temporal flexibility, or outside options. Effects can also propagate beyond the scale at which the allocation is administered. A local infrastructure decision can alter regional access; an organizational allocation can affect a supply network; a national rule can change transnational positions.

The architectural contribution is to keep these conditions available without presuming that every allocation requires multiscale or historical reconstruction. The analyst should retain the smallest representation that preserves the mechanisms material to the claim. When history matters, the relevant question is how inherited relations, boundaries, capacities, or constraints condition present conversion and later consequence rather than whether every present allocation must be explained by an exhaustive genealogy.

12.28.5 Requirements Handed to Allocation Analysis

The chapter can therefore hand a bounded set of requirements to Chapter 13. An allocation analysis may need to specify the allocated object, distinguish receipt from effective access, identify the relevant recipient and incidence boundaries, record conversion conditions, trace materially affected relations or higher-order configurations, locate consequential scales and asymmetries, and preserve historical conditions that alter later possibilities. These are requirements on the representation of allocation, not a theory of how allocation should occur.

Proposition 12.177 (Architectural sufficiency for allocation inquiry). *An allocation representation is architecturally sufficient for a stated inquiry when it preserves the objects, access conditions, boundaries, relations, scales, asymmetries, and historical dependencies whose omission would materially alter the relevant explanation or evaluation. Additional relational detail is unnecessary where those omitted dimensions do not affect the claim.*

Proposition 12.177 closes Chapter 12 at the level appropriate to an economic architecture. It identifies what later allocation analysis may need to inherit while leaving the allocation mechanism, recipient forms, enabling conditions, temporal and spatial design, adaptive revision, and evaluative architecture to Chapter 13. The boundary preserves continuity across Part V without requiring Chapter 12 to pre-construct the substantive theory that follows.

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