

From Aviation to Governance

A Methodology for Identifying Candidate Operational Invariants

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Abstract

The study of governance has concentrated on institutions, incentives, legitimacy, and the modes by which rule is exercised. It has attended far less to a different order of question: by what operational means any governing arrangement, whatever its institutional form, sustains reliable action when information is incomplete, conditions shift, and error is costly. This paper takes that operational order as its object and proposes a way to study it. Its instrument is a single mature domain, civil aviation, whose accumulated practice under uncertainty is unusually explicit; its aim is to extract from that domain what we call candidate operational invariants, operational functions that a governing arrangement may preserve across changes of scale, culture, organizational type, historical period, and the presence or absence of adversaries. The word invariant is used in its exact sense, as preservation under a specified group of transformations, and a candidate is admitted only with the transformations it is claimed to survive and the observations that would show it does not. The contribution is therefore a method, and the candidates are its worked output. Aviation furnishes the first application of that method; whether the candidates it yields survive beyond aviation is the question the method poses and the later work it invites, and it remains open here.

Keywords: governance; operational invariants; high-reliability organizations; renormalization; reliability under uncertainty; methodology.

A note on the standing of this paper. This is a methodology paper built on a single case. It takes one mature operational domain, aviation, and asks whether the functions it has developed for acting reliably under uncertainty can be extracted as candidates worth testing across governance more widely. The candidates offered here have the standing of hypotheses; each is stated together with the transformations it is claimed to survive and the observations that would falsify it. No cross-domain validation is performed, and none is claimed. Should the reliability literatures be shown already to contain the method proposed here, the paper loses its ground. Objection, correction, and counter-evidence are welcome at huangwanhong@serendip.ngo.

1 INTRODUCTION

The study of governance is, for the most part, a study of institutions and their justification. It asks which arrangements of authority are legitimate, how incentives may be set so that self-interested actors produce tolerable collective outcomes, by what modes rule is exercised and contested, and how the resulting order is to be evaluated against standards of justice or efficiency. These are the right questions for much of what governance is, and the traditions that pose them are deep. They share, however, a common level of attention. They are concerned above all with the constitution of a governing arrangement, with what it is and by what right it stands; its conduct from one hour to the next, under conditions it did not choose, receives a lighter share of their attention.

There is a second order of question, less often posed in these terms, which concerns the operation of an arrangement, a matter lying beneath its constitution. Any body that governs anything, a state, a firm, a hospital, a household, an open-source project, must act on incomplete information, must continue to act as conditions change beneath it, must detect and absorb its own errors, and must do these things reliably enough that the arrangement persists. The means by which it does so are operational, and they lie at a level beneath the institutional. They include the estimation of a situation before a decision is taken upon it, the switching between ordinary and degraded modes of functioning, the maintenance of capacity in advance of its failure, and the conversion of failures into knowledge. These means cut across institutional forms. A hospital and a legislature differ at almost every institutional point, yet each must estimate its state before acting, and each must have some way of continuing to function when a part of it is impaired.

This paper is concerned with that second order of question, and with a difficulty peculiar to it. The operational functions just named are easy to observe in any single arrangement and hard to state in a way that is neither trivial nor false across arrangements. Stated concretely, they are the practices of a particular domain and belong to it. Stated abstractly, they slide toward truisms that no arrangement could fail to satisfy and that therefore explain nothing. The problem is to find, between the concrete practice and the empty abstraction, a level of description at which an operational function is both general enough to travel between domains and specific enough that a real governing arrangement could lack it. Finding that level, and defending the claim that a given function occupies it, is the methodological problem this paper takes up.

Our approach is to begin from a domain in which the operational order of governance is developed to an unusual degree and recorded with unusual explicitness. Civil aviation is such a domain. It has operated for a century under exactly the conditions that make operation difficult, namely uncertainty, irreversibility, and the high cost of error, and it has responded by developing an elaborate and documented body of operational practice, together with an

institutionalized habit of learning from its failures. This makes aviation a convenient place to look. It does not make aviation a source of universal truths, and the paper is at pains not to treat it as one. The domain is used as an observatory, and what is observed there is offered as a hypothesis to be tested elsewhere, not as a law already established.

The central move of the paper is to name the object of that hypothesis precisely. We do not claim to identify the operational invariants of governance. We claim to identify candidate operational invariants, and the adjective carries the paper's entire epistemic weight. An invariant, in the sense we take from physics and hold to throughout, is a quantity preserved under a specified group of transformations; the transformations are part of the claim, and a quantity said to be invariant without them is not yet making a claim at all. A candidate operational invariant is accordingly a function offered together with the transformations it is conjectured to survive, advanced so that the conjecture may be examined and, where it fails, refined or withdrawn. The difference between this and the assertion of invariants is the difference between a hypothesis and a result, and it is the difference on which the paper's defensibility rests.

The contribution is therefore a method, of which the candidates are the worked output. The paper offers, first, a working notion of invariance that fixes both the transformations under which a candidate must be preserved and the conditions under which it must be rejected, so that the extraction of candidates has the power to discriminate among functions and does more than abstract from them. It offers, second, a worked application of that notion to aviation, in which a small number of candidate functions are extracted and each is put through the same test. It offers, third, the outline of a research program in which candidates extracted from one domain are carried to others and either survive or do not. What the paper does not offer is the outcome of that program. The candidates are left as candidates, and the work of validation is named as work, so that the ambition of the enterprise does not outrun the evidence a single case can bear.

The remainder proceeds as follows. Section 2 sets the operational question against the literatures that have already studied reliability under uncertainty, in order to mark both the debt this paper owes them and the point at which it departs. Section 3 develops the working notion of invariance, naming the group of transformations and the conditions of failure. Section 4 states why aviation is used and, more importantly, the limits of what a case so chosen can show. Section 5 carries out the extraction, running each candidate through the test of Section 3. Section 6 generalizes the procedure into a program for invariant discovery. Section 7 sets down the limits of the whole, and a short conclusion follows.

2 THE OPERATIONAL GAP AND PRIOR ART

The claim that governance theory has neglected the operational order must be made with care, because a substantial body of work has studied precisely how organizations act reliably under

uncertainty, and this paper builds upon that work and leaves it standing. Three literatures are pertinent, and the paper's relation to each is one of debt qualified by a specific departure.

The theory of high-reliability organizations grew from the observation that certain organizations operate hazardous technologies for long periods with remarkably few catastrophic failures, and asked what allows them to do so. LaPorte & Consolini (1991) set out the theoretical challenge such organizations pose to a social science accustomed to treating reliability as a by-product of structure, and Roberts (1990) characterized the features that distinguish one class of them. Weick et al. (1999) gave the tradition its sharpest early statement, locating reliability in a set of ongoing cognitive processes they named collective mindfulness: a preoccupation with failure that treats small anomalies as symptoms, a reluctance to simplify interpretations, a sensitivity to operations as they actually run, a commitment to resilience, and an underspecification of structures that lets decision migrate toward expertise under stress. Several of these processes reappear, renamed and rescoped, among the candidates of Section 5, and the debt is direct. Closest of all to the present concern is the study by Weick & Roberts (1993) of cognition on carrier flight decks, which treats reliable operation as a property of heedful interrelation among actors, a level above any single actor's competence, and which reads, in effect, as an extraction of operational function from the same domain this paper uses.

What this literature did not do, because it was not its purpose, was to ask whether the processes it identified are invariant in any exact sense, or under what transformations they are preserved. It described the reliable organization and traced its habits with care; it left those habits attached to the organizational form in which they were observed. Collective mindfulness is offered as a characterization of a kind of organization, and the question this paper presses, namely whether a given process survives the passage to arrangements that are not organizations of that kind at all, to households, to states, to voluntary communities, and whether it survives the passage to settings where the parties do not share an end, is a question the tradition had no occasion to raise. The present paper takes the processes the tradition surfaced and asks of each the question the tradition left open.

Resilience engineering approached a neighboring question from the side of design. Hollnagel et al. (2006) and the tradition around them shifted attention from the prevention of failure to the maintenance of function under disturbance, treating the capacity of a system to adjust its functioning before, during, and after change as the proper object of study. This is close to the operational order named here, and the debt is direct. The difference, once more, is one of aim. Resilience engineering seeks to build systems that hold; the present paper seeks a method for deciding which of the functions such systems exhibit are invariant across domains, which is a question about the transportability of a function, one step removed from its realization in a given system.

Normal accident theory supplies the necessary counterweight. Perrow (1984) argued that in systems of sufficient interactive complexity and tight coupling, serious accidents are normal

properties of the system, native to its structure, so that no accumulation of operational practice can render such systems safe. The lesson for this paper is cautionary, and it is taken seriously in Section 4. If some operational functions are defeated by the very structure of the systems they are meant to protect, then the invariance of a function cannot be inferred from its usefulness, and the failure conditions of Section 3 must have real teeth. Normal accident theory is, in effect, an argument that candidates can fail, and the method proposed here must be able to record such failures and let them stand.

The novelty claimed by this paper is accordingly narrow and, we think, defensible. The observation that aviation uses checklists, and the discovery that some organizations are reliable, both belong to the literatures just named, and the paper claims neither. Its own proposal is to treat operational functions as candidate invariants in the exact sense, to fix in advance the transformations under which they must be preserved and the conditions under which they must be abandoned, and to make the extraction and testing of such candidates a research program in its own right. The literatures above furnish the raw functions and the warning that functions can fail. The method for turning those functions into testable cross-domain claims is what this paper adds.

3 A WORKING NOTION OF INVARIANCE

Before extracting anything from aviation, we owe the reader an account of what would make a candidate deserve the word invariant, and of what would make one fail. Without such an account, extraction is not discovery. One may take almost any operational practice, describe its function at a sufficiently high level of abstraction, and arrive at a statement general enough to sound independent of its domain. The generality would then be an artifact of the phrasing, owing nothing to governance itself. This section fixes the criteria that prevent that outcome, and it fixes them before the case is examined, so that the case cannot be arranged to meet them.

3.1 *Invariance as preservation under a transformation group*

We take the word invariant from physics deliberately and keep its structure intact. In physics a quantity is never invariant in itself; it is invariant under a specified group of transformations, as a length is invariant under rotation, an interval under a change of reference frame, a critical exponent under coarse-graining. The transformation group is what gives the claim its content, for to say that a quantity is preserved is to invite the question, preserved under what, and a claim that cannot answer it asserts nothing testable. We therefore commit in advance to the transformations under which a candidate operational invariant must be preserved if it is to earn the name. A candidate is a claim of the form: this operational function survives transformation T . We propose five transformations as the working group for governance.

Scale. *The passage from a small arrangement, a two-person cockpit or a household, to a large one,*

an agency or a state. A function that holds for the few and dissolves for the many is scale-dependent, and it fails under this transformation.

Culture. *The passage across differing norms of authority, communication, and trust. A function that presupposes one culture's relation to hierarchy has failed once the change to another culture removes it.*

Organizational type. *The passage across firms, states, non-governmental bodies, households, and voluntary communities. A cross-domain program principally tests this transformation, since it is the one under which surface implementation differs most.*

Historical period. *The passage across technological and institutional eras. A function tied to the tooling of one period belongs to that period as an implementation of it, and its survival across eras remains to be shown.*

Adversariality. *The passage from cooperative settings, in which the parties share an objective, to contested ones, in which their objectives conflict. This is the most demanding of the five, and, as Section 4 argues, the one that aviation is least equipped to probe.*

A candidate may be of interest even where it survives only some of the five transformations, provided the discipline of the method is kept: we must always say which transformations it is claimed to survive and which lie beyond its reach. A function scoped to scale and historical period, with adversariality left outside its claim, is a sharper and more honest object than a function offered as invariant without qualification. The scoping is the content of the claim, and the claim gains its precision from it.

3.2 Functions, not implementations, under coarse-graining

The transformations of the working group apply to functions, leaving implementations aside, and the distinction is what a renormalization view contributes to the method. Coarse-graining, in the sense given to it by Kadanoff (1966) and Wilson (1971), asks whether a quantity survives when we cease to resolve fine detail and describe a system at a higher level. An aircraft checklist, a surgical timeout before an operation, and a household's agreed plan for emergencies are not alike as practices, and no inspection of their surfaces would group them. They may nonetheless instantiate a single function that survives coarse-graining across all three, namely the external stabilization of correct execution when the cognition of the actor is degraded by stress, fatigue, or haste. The claim is never that the practice is universal, for checklists plainly are not; it is that the function the practice serves is preserved when the practice's specific form is coarse-grained away.

This shifts the object of study from surface similarity to functional equivalence, which is at once the richer question and the harder one. It also imposes a burden on anyone who would advance a candidate. The candidate must be stated at the level of function from the outset, and its proponent must be able to say what the function is independently of any single real-

ization of it. The sentence “checklists are invariant” is not a candidate, because it names an implementation. The sentence “the external stabilization of execution under degraded cognition is preserved under coarse-graining across implementations” is a candidate, because it names a function and specifies the operation, coarse-graining, under which the preservation is claimed.

3.3 Conditions of failure

A criterion that never rejects anything is not a criterion. If every practice observed in aviation yields a candidate, then extraction has no power to discriminate, and the paper collapses back into the abstraction it set out to avoid. We therefore state, in advance of the case, the conditions under which a proposed candidate is to be rejected or downgraded.

Implementation-boundness. *The proposed function cannot be stated without reference to a mechanism specific to aviation, a particular instrument, regulation, or role. When this is so, what was offered as a function is in truth an implementation, and it has not survived coarse-graining.*

Transformation failure. *A plausible instance under one of the five transformations removes the function altogether, leaving nothing to re-implement. A function that vanishes the moment objectives become adversarial has failed under the adversariality transformation, and it must be rescoped to exclude that case or abandoned.*

Vacuity. *The function is stated so abstractly that every governing arrangement exhibits it, and no counterfactual arrangement, one that operates without the function and is the worse for the lack, can be described. A candidate that survives every transformation by saying nothing, in the manner of the sentence “governance involves acting,” is a definition wearing the dress of a finding.*

These three conditions are what give the candidates of Section 5 the status of hypotheses. Each candidate is required to state both the transformations it claims to survive and the observation that would show it does not, and a candidate for which no such observation can be named is, by the third condition, refused admission.

4 THE AVIATION CASE AND ITS SCOPE

Aviation is used here as an observatory, and the choice needs both a justification and a boundary. The justification is that aviation has developed the operational order of reliable action further, and recorded it more explicitly, than almost any comparable domain. It has operated for a century under uncertainty and irreversibility, it codifies its procedures in a way that makes them available for inspection, and it has institutionalized the study of its own failures to a degree that few domains match. For the purpose of extracting operational functions and seeing them clearly, these are precisely the properties one wants. Aviation puts the operational order on the surface, where it can be read.

The boundary matters more than the justification, because it is where the paper's honesty is tested. Aviation is not a neutral sample of governing arrangements. It is a domain that was deliberately and expensively engineered toward reliability across decades, and its operational order bears the marks of that engineering. Its characteristic failures are rare and catastrophic where those of other domains are frequent and diffuse; its components are tightly coupled; its operators are trained experts, selected and drilled for the role; and, decisively, its setting is cooperative. The parties in a cockpit, in an air traffic control system, and in a maintenance organization share an objective, the safe completion of flight, and their ends run together. Whatever operational functions aviation has developed have been developed under these conditions and are shaped by them.

Two consequences follow, and the paper accepts both. The first is that the candidates extracted from aviation will be biased toward the profile of the domain. They will be the operational functions of an engineered, tightly coupled, expert, cooperative system, and their apparent generality must be treated with suspicion exactly where the target arrangement departs from that profile. The second consequence fixes the scope of the paper's claim. Aviation illuminates the reliability dimension of governance, the dimension concerned with sustaining correct action under uncertainty, and it is largely silent on the dimensions that much governance theory treats as central, namely the contest of conflicting interests and the exercise of power among parties who do not share an end. A candidate extracted here is, until shown otherwise, a candidate for the reliability dimension only.

This scoping belongs to the method as one of its working parts, and it connects directly to the adversariality transformation of Section 3 and to the caution of normal accident theory. Because aviation is cooperative, it cannot itself test whether a function survives the passage to adversarial settings; that transformation must be probed in domains aviation does not reach. And because, as Perrow (1984) argued, some systems defeat operational practice by their very structure, the usefulness of a function within aviation leaves its survival elsewhere an open question. The case is therefore strong for the work it is asked to do, the clear surfacing of candidates, and it stops short of the further work of establishing them. Holding those two roles apart is the discipline the rest of the paper tries to observe.

5 CANDIDATE EXTRACTION FROM AVIATION

This section applies the method of Section 3 to the case of Section 4. It is a demonstration of the procedure, standing at one remove from the substance of the paper's claim; the candidates that follow are worked examples of extraction, offered so that the method may be seen to bite, and at least one is included because the failure conditions visibly strain it. Each candidate is set out in the same order: the aviation practice from which it is drawn, the operational function that practice serves, the candidate invariant stated at the level of function, the transformations

it is conjectured to survive, and the observation that would show it does not.

5.1 State estimation before decision

The practice, in aviation, is the disciplined construction of a picture of the situation before a decision is taken upon it: the scan of instruments, the cross-check of one source against another, the explicit recognition that an instrument may be unreliable and must be confirmed against others. On a crewed flight deck this construction is distributed across actors who cross-check one another, and Weick & Roberts (1993) treat exactly this heedful mutual monitoring as the seat of reliable operation, which places the practice at the level of a small collective and not only of a single operator. The operational function is the separation of estimating the state of the world from acting upon it, so that action is taken against a representation that has been deliberately assembled. The candidate invariant, stated under coarse-graining, is that reliable governance requires an explicit stage of state estimation prior to optimization, held distinct from the choice of action and kept from collapsing into it. The transformations it is conjectured to survive are scale, culture, historical period, and organizational type; a household, a firm, and a public agency may each be said to estimate before deciding. Its survival under adversariality is doubtful and is left open, since where parties contest the state itself, estimation ceases to be a shared prior stage and becomes a move in the conflict. The observation that would falsify the candidate is a governing arrangement that reliably acts well with no separable estimation stage, folding assessment into action without loss; were such arrangements common, the separation would be one style among several, its claim to invariance lost.

5.2 Mode-switching between normal, degraded, and emergency operation

The practice is the maintenance of distinct operating modes with defined transitions between them, so that an aircraft is flown differently, by different procedures, when systems are normal, when they are impaired, and when an emergency is declared. The operational function is the replacement of a single universal decision procedure by a small set of regimes, each matched to a condition, with explicit criteria for passing between them. The candidate invariant is that reliable governance distinguishes operating modes and manages the transitions among them, in place of governing by one procedure across all conditions. The transformations it is conjectured to survive are scale, organizational type, and historical period; arrangements of many kinds carry some notion of ordinary functioning as against emergency functioning. Its survival under culture is only partial, since what counts as an emergency and who may declare it are culturally shaped, and this qualification is stated openly. The falsifying observation is a reliable arrangement that governs uniformly across radically different conditions and is no worse for it; were such arrangements ordinary, mode-switching would stand as an aviation habit, its claim to invariance withdrawn.

5.3 *Externalized procedural memory*

The practice is the checklist, and more broadly the placing of required steps in an external artifact, held outside the memory of the actor; the design of such artifacts is itself a studied subject, and Degani & Wiener (1993) document how much of a checklist's reliability turns on details of its form, over and above its mere existence. The operational function, already used above as an illustration, is the external stabilization of correct execution when the actor's cognition is degraded by stress, fatigue, load, or haste. The candidate invariant, under coarse-graining, is that reliable action under degraded cognition is supported by externalized procedural memory, whatever the form the artifact takes. The transformations it is conjectured to survive are broad: scale, culture, organizational type, and historical period all appear to leave the function intact, since the surgical timeout, the legal filing checklist, and the household emergency plan realize it differently while preserving it. This candidate is the strongest of the four on its face, and for that reason it is the one on which the vacuity condition must be pressed. The guard against vacuity is the counterfactual: there exist arrangements that rely wholly on the trained memory of expert individuals and that fail, distinctively, when those individuals are impaired, and the function names exactly the difference between such arrangements and those that externalize. Because that counterfactual can be described, the candidate is not vacuous; were it undescribable, the candidate would be a definition in disguise and would be withdrawn.

The breadth of the candidate's claimed survival is itself a warning, and honesty requires that the warning be stated. A function that appears to pass four transformations at once may owe its success to the height of its phrasing, and the finding by Degani & Wiener (1993) that a checklist's form governs its effect supplies the concrete danger: the coarse-grained function survives the passage across domains precisely where the fine detail that makes an artifact work does not. The candidate as stated is therefore true and thin. It holds that externalized procedural memory supports reliable action under degraded cognition, and it is silent on the conditions that divide a helpful externalization from a harmful one, which is where the operational content lives. This is a candidate that the method admits and then marks for refinement, since its survival across transformations has been bought, in part, by abstracting away the very features a later and narrower candidate would need to name.

5.4 *Institutionalized post-event learning*

The practice is the investigation of incidents and accidents as a matter of routine, conducted so that failures become inputs to revised procedure, with blame set to one side. The operational function is the conversion of failure into knowledge through a standing mechanism that operates whether or not any individual chooses to learn. The candidate invariant is that reliable governance institutionalizes learning from its failures, so that the conversion of failure into revised practice holds independently of individual will. The transformations it is conjectured to

survive are scale, organizational type, and historical period. Its survival under adversariality is where the candidate strains most instructively, and the strain is worth stating plainly. In cooperative settings the investigation of failure is a shared good; in adversarial ones the record of failure is itself contested, since to establish what failed and why is to assign fault among parties who resist it, and the standing mechanism that aviation relies upon presupposes an authority to investigate that adversarial settings may lack. The candidate therefore appears to fail, or at least to require heavy rescoping, under the adversariality transformation, and by the honesty the method demands this stands on the page as a limit of the candidate. The falsifying observation, within the reliability dimension, is a durable arrangement that learns reliably from failure with no institutionalized mechanism at all, purely through the initiative of individuals; the candidate predicts that such arrangements are fragile across turnover, and evidence that they are not would tell against it.

5.5 *The yield of the extraction*

Four candidates have been drawn from aviation, and their standing is that of hypotheses, held short of the operational invariants of governance. They are offered to show that the method of Section 3 does real work. It forces each function to be stated independently of its aviation implementation; it requires each to declare the transformations it claims and to concede those it does not; and it has, on two of the four, produced strain of the kind a working criterion should produce. Institutionalized post-event learning visibly fails under adversariality, where the contest over the record of failure removes the shared authority the function presupposes. Externalized procedural memory shows the opposite pathology: it passes almost every transformation, and the very breadth of that success exposes it as pitched too high, true across domains at the cost of the fine detail in which its operational content resides, so that the method admits it and marks it for refinement. A set of candidates that passed cleanly and uniformly would be evidence that the criteria could not bite; the two strains are evidence that they can. The extraction has surfaced hypotheses with their falsifiers attached. Whether the hypotheses hold is a question for the program the next section describes.

6 A PROGRAM FOR INVARIANT DISCOVERY

The procedure carried out on aviation generalizes, and stating it as a general procedure is the paper's principal contribution. The steps are five. First, one selects a mature domain in which the operational order of reliable action is highly developed and explicitly recorded, and extracts from it operational functions stated at the level of function, with their implementations set aside. Second, one states each function as a candidate invariant, attaching to it the transformations from the working group that it is conjectured to survive and those it is not. Third, one carries each candidate to domains that differ from the source under the transformations at is-

sue, and observes whether the function survives the passage or is destroyed by it. Fourth, one refines the candidates that survive in altered form, rescopes those that fail under particular transformations, and withdraws those that fail generally or prove vacuous. Fifth, and only for candidates that have survived a range of transformations, one seeks a formal representation of the surviving function, so that it may be compared and composed with others with more precision than prose allows.

The posture of this program differs from the prevailing one in governance research, and the difference is the point. Much of that research proceeds by the proposal of frameworks, each internally coherent and each competing with the others for adoption, so that progress comes to be measured by the proliferation of frameworks, with the elimination of error left aside as a standard. The program proposed here measures progress differently. It advances by subjecting candidate functions to transformations that may destroy them, and it counts the destruction of a candidate as a result in its own right. Its aim is a slowly accumulating set of functions that have survived the attempt to break them, together with a record of exactly which transformations each has survived; a preferred model of governance lies outside that aim. Whether such a set can in fact be assembled is not settled by this paper. What this paper settles is the form the attempt should take, and the discipline, drawn from the exact meaning of invariance, that would let its candidates fail honestly.

7 LIMITS OF THE ACCOUNT

The account rests on claims that may be wrong, and setting them down as such belongs to the account. Its empirical base is a single domain, and a single domain of a particular profile at that; the candidates of Section 5 bear the marks of an engineered, cooperative, expert system, and their bias toward that profile is a property of the method's starting point, native to it and carried forward from it. The low adversariality of the case is the sharpest of these limits, since it leaves the most demanding transformation of the working group essentially untested from within the paper, and the reliability dimension to which the paper scopes its claims is precisely the dimension least exposed to the contests of interest and power that occupy much of governance theory. The abstraction risk named at the outset persists to the end: generality can be manufactured by phrasing, and the failure conditions of Section 3 stand guard against that manufacture while falling short of a proof against it, a discipline whose force depends on being observed with care, its hold loosening the moment it is observed loosely. Finally, no validation is performed here. The candidates are carried nowhere; they are stated with their falsifiers and left standing, and the work of taking them into other domains, the work on which their status as invariants entirely depends, is named as the work this paper opens and does not do.

8 CONCLUSION

Governance has an operational order that its dominant literatures, fixed on institutions and their justification, have tended to look past, and that order can be studied. This paper has proposed a way of studying it that borrows the exact meaning of invariance from physics, fixes in advance the transformations under which an operational function must be preserved and the conditions under which it must be abandoned, and uses a single mature domain as an observatory from which candidate functions may be drawn. Aviation has served as that observatory, and four candidates have been extracted from it, each stated at the level of function, each declaring the transformations it claims to survive, and one of them failing openly under the transformation it cannot meet. The candidates are not the paper's contribution. The contribution is the method that produced them and that would, applied across further domains, either establish them as invariants of the reliability dimension of governance or break them. Which of these occurs is the question the method poses. Posing it so that the answer can go against the conjecture is what this paper has tried to do.

A note on method. The word invariant is used here in its exact sense, as preservation under a specified group of transformations, and it is kept clear of the loose honorific sense in which a thing is called invariant merely for being general or important. Where the paper cannot name the transformation under which a function is claimed to be preserved, it says so and lowers the claim accordingly. No formal representation of the candidates is attempted. Two honest presentations of the material are available: clear prose, and, in later work, a genuine connection to the language of dynamical systems, in which an operational function would answer to an invariant of the arrangement's own dynamics with the exactness a figure of speech lacks. Only the first is claimed here.

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