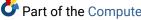1984

Incompleteness, Negation, Hazard: On the Precariousness of Systems

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ABSTRACT

An account is offered of the dialectical tensions which afflict systems of widely differing type, "contradictions" which cannot be fully or permanently resolved, and from which follow the lawfulness of both hazard and opportunity.

INTRODUCTION

Mario Bunge (1973) has provided a deep and succinct characterization of systems and cybernetics theories, e.g., information theory, game theory, automata theory, and the like, as attempts to construct an exact and scientific metaphysics. These theories can be considered "metaphysical" in their generality, "exact" in being mathematical, and "scientific" in having a close connection with specific theories in one or more scientific disciplines. This view is fundamentally in close agreement with the goals of general systems theory and/or cybernetics as expressed by Boulding, von Bertalanffy, Wiener, Ashby, and others.

This paper develops the outlines of a metaphysics of "problems," an account of the nature and origin of those difficulties which afflict many different kinds of systems, difficulties which reflect contradictions intrinsic to being and to becoming which can never be completely resolved.(The word "contradiction" is used in its dialectical and not logical meaning, i.e., to denote the coexistence of opposing forces, needs, tendencies, etc. No distinction is made in this paper between "concrete" and "conceptual" systems. Emphasis on the former is intended, and terms which properly belong only to the domain of the latter are used metaphorically.) Such difficulties are lawful and ubiquitous. This analysis serves as a necessary corrective to the tendency of systems thought to assume or to overemphasize the stability and internal harmony of systems and to neglect dysfunction, conflict, and change. What is outlined here is an entity-based metaphysics which takes the existence of entities to be intrinsically precarious.

This essay is a synthetic effort, and constraints of space make it impossible to "unpack" the technical and philosophical allusions of the narrative. An expanded version of this paper which details specific connections to the sources listed in the bibliography and to other works in the systems literature will be published elsewhere. The present text seeks to demonstrate that a coherent ontology is implicit in systems-theoretic ideas by casting these ideas into the form of a metaphysical discourse.

SYNCHRONICS

Every system is constructed around some organizing principle, and every organizing principle is inherently limited. In the domain of existence of any system, only certain elements can be brought into coherent relation; some elements must be left out. Unity is gained at the expense of partialness. In the impossibility of universality, every system is intrinsically incomplete.

A system may be structured around more than one organizing relation. However, these are either organized in turn into a superordinate whole on the basis of a more global principle, or they coexist independently, unharmonized at a higher level, and at least potentially in a state of contradiction.

Dialectically speaking, every system is inevitably and necessarily flawed. This imperfection cannot be avoided. It arises from the fact that any existing organizing relation is partial in scope. Within a restricted domain, a degree of consistent order can be achieved. But consistency and completeness cannot both be attained. The whole cannot be embraced.

A system is a union of opposites: variety, in the multiplicity of states of the elements entering into the system, and constraint, in the relations which restrict the independent variation of these states and thus define the organizing principle of the system. Constraint upon variety marks off the domain of the actual from the domain of the possible. But the exclusion produced by this demarcation is not permanent or unconditioned. The possible exists and influences the actual.

The organizing principle is the identity of the system and the basis of its dynamic activity vis-a-vis its environment. This order, to persist, must to some degree be isolated from disturbing influences. Every system must in some measure be closed. The organizing principle provides for the closedness of the system and is protected by it. In a deeper sense, the organizing principle is itself the closedness of the system, its integrity and identity.

But to the degree to which and in the manner by which a system is closed, it is vulnerable to a dual risk: it tends either to disintegrate or to rigidify. Disintegration into chaos is foreordained for isolated systems. The lawful consequence of the inexorable flow of time cannot be avoided, but the actual time period over which disintegration need take place is not prescribed. Through rigidification, this outcome may be postponed. but the system is then forced towards a condition equally dire: the cessation of dynamic activity. Though tendencies of disintegration and rigidification are opposites, they are often linked; and isolated systems may, at least for a while, suffer both processes simultaneously.

Complete isolation, however, is only a useful fiction. All systems are open in some way to their environments. In this openness there is the possibility of self-maintenance, i.e., the preservation of internal order and identity. The tendencies within a system towards disintegration and/or rigidification may be checked or brought into balance. External order may be absorbed and internal disorder expelled to counter the former tendency; internal disorder may be retained or external disorder taken in to neutralize the latter. This is a delicate task. In openness, there is merely the possibility of homeostasis, not its guarantee. The transactions of the system with its environment, if unbalanced or improperly controlled, can bring about more rapid disintegration than would occur if the system were closed.

Complete openness, like complete closedness, is impossible. The existence of a system distinct from its environment requires a boundary, i.e., a degree of closedness. A system too open suffers the same fate as one too closed. A totally open system reaches equilibrium with its environment, becomes indistinguishable from it, and disappears. To be clear: openness does not eliminate the

dual risk which systems face of movement towards chaos and/or rigidity. These tendencies are inevitable because they originate in two fundamental, yet contradictory, requirements. The existence of the system -- of its organizing relation and of the system/environment distinction -- depend on order and unity. Yet variety and multiplicity are also necessary to insulate the internal order of the system against the buffeting disturbances of the environment, disturbances to which the system, necessarily open in part, cannot avoid being exposed. External disturbances can be matched and countered by sufficient internal variety. Variety, however, is beneficial disorder, and is distinguishable from harmful disorder only by its effects on the system. These effects, and thus this distinction, are not permanent, but change with circumstance.

Every system thus necessarily subsists partially open and partially closed, or open on some occasions and closed on others. Moreover, the particular way in which the conflicting needs for both closedness and openness are reconciled is itself either part of the system's closedness or openness. That is, either the organizing relation provides explicitly for the transactions which will occur between system and environment, or, more critically, for the maintenance of some system invariant, in which case the system remains tethered to some quasi-permanent order; or, nothing is held invariant, and the system is subject to being completely altered by its adjustments to and by the impacts of environment. In the former case, identity is protected but adaptability is limited in the latter case, adaptation through evolution is possible but at the sacrifice of fixed identity.

Closedness and openness are temporal as well as spatial. Closedness is the embedded residue of the past. Openness is contact with the present. The organizing principle is the legacy of the past and cannot be renounced; nor can the challenge of the present be ignored. Rule by the external present is drift or bondage. Rule by the internal past is inertia or fantasy. Autonomy requires openness to the outside world, yet internal patterns must have some priority over external influences. How past and present can be joined in autonomous and creative action cannot in general be specified.

Though necessary for autonomy, openness subjects the system to uncertainty and risk. The capacity of the environment as either source or sink for order or disorder is always limited. The environment is rarely spatially uniform or temporally invariant. There may be texture in the distribution of resources and noxiants. The environment may include independent and competing systems. Or, the system may overlap other systems which organize different attributes of common elements. The environment may be sufficiently structured as to constitute a superordinate order in which the system is constrained as an element.

Texture in the environment exposes the system to vagaries of chance. The presence of other systems may add competition and conflict. Sharing of elements violates integrity of boundary and generates points of tension. Being embedded in a more encompassing order compromises autonomy.

The last of these conditions poses the deepest challenge. By virtue of inevitable incompleteness, systems have the capacity, often the tendency, to become integrated into larger wholes. Yet each system is also a whole unto itself and in relation to its parts. The competing needs of system and suprasystem may for a time be harmonized, but the tension which inheres in this relationship can

never completely be resolved. Moreover, systems are often integrated as elements into more than one larger whole and thus become the field of higher level contradictions.

Yet, alternatively, it may be precisely the absence of a superordinate order which endangers the system. Unrestrained competition with independent and rival entities may be detrimental or hazardous. Even where there is also the possibility of cooperation, and even when cooperation is to the advantage of each contending system, there may yet need to exist higher level constraints to stabilize cooperation against the temptation of defection. Moreover, cooperation via mutually-beneficial exchange poses risks for autonomy. Exchange, however necessary or desirable, reinforces and extends incompleteness, and leads to dependence and ultimately to vulnerability. A superordinate order may be necessary to guarantee the stability of exchange and the viability of individual systems.

In turbulent environments, where the system is at the mercy of large-scale external forces, the success of any isolated action is problematic. In these circumstances as well, survival may depend upon the creation or maintenance of suprasystem relations. Yet, though dependence and constraint are often the price of viability, systems invariably resist the loss of autonomy.

Environments thus vary in complexity. To the extent a system is open, it tends to match the complexity of the environment with its own internal complexity. This matching may be implicit and diffused throughout the system, in which case adjustments are slow and difficult to coordinate. Increased complexity may also precipitate instability and disintegration by exceeding the capacity of the organizing principle to integrate and constrain. Or, complexity may be concentrated in a subsystem whose explicit function it is to model the environment, the system-environment interaction, and perhaps even the system itself. Such a model, however, is part of the system and necessarily inadequate. By thus including an image of a more encompassing order, the system does not elude its fundamental incompleteness. Nor can the exact degree to which the model is inadequate be established. Nor can it be reliably ascertained to what extent the model represents reality or illusion.

By means of such a model, higher level constraints may be internalized; some of the advantages of being embedded in a more encompassing order may be gained without compromise of autonomy. To be effective, however, these constraints must be assimilated into the closedness of the system, i.e., must be categorical, not instrumental. Yet benefits may depend upon similar action by other systems which cannot be assured. More fundamentally: by such internalization contradiction may be introduced into the domain of closedness. The endeavor of a system to persevere and be a source of autonomous action rarely can be reconciled with subordination to a higher level order.

This is fundamental: all systems encompass variety and constraint, closedness and openness, unity and multiplicity, autonomy and dependence. Unity, closedness, and autonomy are allied, as are multiplicity, openness, and dependence. A permanent ordering of priority between these constellations of features cannot be established. Openness and multiplicity are necessary to protect the integrity of the system and should ideally be subordinate to it. Yet, unity is flawed by partialness, and closedness may bring about dissolution or rigidification.

These conflicting requirements arise inescapably from incompleteness. The viability of any solution to these dialectical dilemmas cannot be permanently assured. Reconciliation of these contradictions is particular and conditioned, not universal and necessary, and the balance between opposing needs forever remains precarious. Closedness wars on openness. Unity wars on multiplicity. Environments change. Hazard is implicit in the fabric of existence. Persistence cannot be guaranteed by any strategy whatever.

DIACHRONICS

Incompleteness in being engenders becoming. Usually more can be ordered via the organizing principle than what is initially subsumed in the system. In openness, there is not only the possibility of self-maintenance, but also of growth and development. The system assimilates elements from its environment and extends its domain of influence.

For a period, the identity and viability of the system may be unchallenged and expansion sustained in momentum. In this success, however, consequences of the restricted scope of the organizing principle begin to appear. Growth slows, and obstacles are encountered to further development. Thus the dialectical trajectory: the development of the system proceeds from nucleation to expansion to the encountering of limitation.

Obstacles appear in many forms: in the exhaustion from the environment of elements suitable for incorporation or transformation; in the difficulty of maintaining coherence while integrating new elements into the system; in the fragility of order already achieved; in conflict generated by subsidiary internal structures not completely subordinate to the original organizing principle; in constraints stemming from the competition of other systems or from a higher level order. Circumstances vary, but unimpeded development never occurs.

Nucleation, expansion, limitation: this sequence of early stages is nearly foreordained. As development continues, the factors limiting development also intensify. If the system continues along this trajectory, eventually a critical phase is reached in which the intensification of hazard emerges as a lawful feature of development. The unique properties of the system, i.e., its particular structure, function, and history, gain in importance over more generic attributes, and the future of the system becomes more uncertain. The system enters a region of bifurcation in which its actual state comes to coexist, in the realm of the possible, with a second, potential, state, which corresponds either to the dissolution of the system or to its restructuring. This coexistence of actual and potential states defines the "principal contradiction" which now characterizes the system and its development. Thesis leads to antithesis, and not by failure but by success.

Limitation is internal or external. It derives from general difficulties of systems maintenance and development or from the existence of a specific opposing organizing principle. These four archetypal situations which are possible all have, as the prime source of their arising, the necessary partialness of the organizing principle by which the system is constituted. Development invariably gives rise to its own negation. What is omitted eventually hinders or afflicts what is included.

The fundamental character of limitation is most apparent when it arises internally and when it reflects general difficulties of systems maintenance. For example, there may be an intensification

of the dilemma which inheres in opposing needs for closedness and openness. A tension between these needs characterizes all systems, but may require time in any particular system to manifest. When some successful development has occurred, conflict invariably is engendered between that which, for integrity, must be fixed and that which, for adaptability, must vary. Often it is openness which predominates in the early stages of development, fostering the growth of the system and the realization and articulation of the organizing principle. However, with the formation of a complex internal order, the need for the protection of this order against disorder of internal or external origin gains in importance. Closedness, necessary always to some degree, becomes more imperative. The system centralizes; an inner core is formed which begins to rigidify.

Development entails progressive segregation, complexification via the differentiation of subsystems. The unity of the organizing principle is sacrificed for its fuller realization and articulation. As global higher order relations are weakened, the system become partially decomposable. Asymmetrical relationships develop between higher and lower levels, between the more centralized portion of the system which is the guardian of unity and its more exterior portion which reflects its necessary multiplicity. As the distance increases between center and periphery, the center tends to rigidify and the periphery to disintegrate. Tension develops between those factors maintaining unity and closedness and those providing multiplicity and openness.

Ideally, relationships between subsystems and between center and periphery are characterized by complementarity and reciprocal benefit, but may also be the basis of unequal exchange, exploitation, and conflict. Even in the absence of pronounced adversarial relationships, rarely does the structure of a complex system embody an optimal synthesis of centralization and decentralization.

Development entails the non-proportional growth of parts. This may require modifications in the organizing principle, but the extent to which such modifications are possible and the degree to which they can compensate for structural disproportion is ultimately limited by the closedness of the system. Alternatively, development may be fully subsumed within the invariant order. The organizing principle may specify not a static archetypal form but a dynamic unfolding of structure. But the adaptiveness of the results of this unfolding cannot be guaranteed. And if the development of a system is programmed, so too is its demise.

In some circumstances, obstacles to development are more concentrated and active. There may emerge within the system a distinct alternative and competing order. If development follows its most natural course, the opposition of the organizing principle and its negation will intensify into conflict. This conflict may lead to the ascendancy of the new order. Usually, the system remains structured for a time in its initial form, but continued shifts in dominance towards the new mode of organization finally make visible what has hitherto been latent. A crisis ensues in which the change, already accomplished in deep structure, manifests also in surface structure. Finally, there is actual transformation: the system yields to its negation.

The struggle of opposites may result instead in the triumph of the original principle. Victory, however, is rarely complete. Those aspects of the system which gained coherence by the alternative mode of organization may remain within the system, in which case contradiction is

fixed within the system and produces in it a permanent strain. The organizing principle suffers distortion. Its continued dominance requires the suppression of the fact of its incompleteness and the existence of an alternative mode of organization. The success of this suppression cannot endure forever. Or, parts of the system substantially ordered by the new principle may be expelled. The problem is externalized but not solved: conflict with the competing system thus generated invariably ensues.

Alternatively, limitations to development may appear as external in origin. Environmental conditions may block further growth. Openness confers upon the system the theoretical possibility of indefinite self- maintenance, but this is never actually achieved. Even if the organizing principle of the system is protected from environmental disturbances, even if the delicate balance between openness and closedness is preserved, still the pool of external resources may become depleted; disorder or noxiants expelled into the environment but remaining nearby may poison it. This negation, while having the character of being external, stems fundamentally from the requirement of openness, and ultimately from the incompleteness of the organizing principle. Only part of the environment can be assimilated into the system; only part of the results of the internal processes of the system can be beneficially retained by it.

In such circumstances, the mode of the system must shift from expansion to homeostasis. Yet such a shift may be impossible - or come too late to prevent - overshoot and collapse. Difficulties in this transition may arise from either the unity of the system or its multiplicity. Expansion may be too deeply embedded in the organizing principle to be modified or abandoned. Or, the independent growth of subsystems, if not subject to higher level constraints, will extend the system beyond its optimal scale. Moreover, a steady state, even if achieved, may not be indefinitely sustainable. No means exist to guarantee such a state in perpetuity.

Or, after expanding its niche, the system may become faced with competing systems organized by different ordering relations. As with the comparable internal situation, conflict may ensue, with varying possible outcomes for the system and its competitors.

Where limitation arises from internal or external competition (as distinct from the more general difficulties of maintenance and development), a synthesis may be possible between rival structures. Internally, there may emerge a superordinate order within which the organizing principle and its negation are harmonized. Externally, the system may become linked to other systems by relations which integrate, constrain, and enrich. The dialectics of reconciliation are, however, demanding and subtle, more so than the dialectics of victory and defeat. The presence of additional factors are necessary to balance and bind together the contending forces. The existence of these factors and thus of the synthesis may be transitory. Indeed, the hazard faced by many systems in the bifurcation region is precisely the fragmentation of an original synthesis by the weakening of those mediating factors.

Faced with internal or external competition or with difficulties of a more general kind, the system may undergo evolutionary change. Dialectical processes are among such evolutionary mechanisms; others, continuous and/or discontinuous, are possible. Evolution is not without cost. In evolution -- as distinct from the morphogenetic realization of some organizing principle --

identity is altered. To the degree a system is tethered to a fixed order, it cannot evolve. In circumstances where evolution is the necessary form of adaptation, survival requires deep opening and the relinquishing of the preexisting order. This is experienced by the system as negation and is resisted. Evolution may be essential for survival, but it is not the original system which survives. From an external perspective, there is perhaps a degree of historical continuity; but to the system itself, evolution means death, in the sense of ultimate loss of identity. The increased viability of a radically different, though genetically related, system does not fully compensate.

Or, the system may follow the archetypal route of organisms. Having reached a full measure of development, it ages and finally passes away. It leaves behind its effects on its environment, which may be considerable and may yet persist. The system is not, by reason of its impermanence, "unsuccessful," for how can permanence be a criterion of success? Decay is inherent in all composite things and survival is itself no mark of merit.

That which flaws being is not remedied in becoming. Development, which negates incompleteness, is itself negated, as the ultimate partialness of the organizing principle becomes manifest. The difficulties necessarily joined to any degree of successful development can be met only if partialness is accepted. This may require deep change in the organizing principle and perhaps even its abandonment.

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