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Source: *The Review of Metaphysics*, Vol. 39, No. 1 (Sep., 1985), pp. 107-135

Published by: [Philosophy Education Society Inc.](#)

Stable URL: <http://www.jstor.org/stable/20128282>

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SELF-ORGANIZATION: KANT'S CONCEPT OF TELEOLOGY AND MODERN CHEMISTRY

ALICIA JUARRERO ROQUÉ

AS IS WELL KNOWN, one of Kant's major concerns was the reconciliation of Newtonian science and metaphysics, a preoccupation made particularly acute by the need to provide a satisfactory explanation of organisms. It is in light of his claim that only the mechanistic principles of Newton's physics can provide scientific knowledge (since those are the principles that are determined by the categories of the Understanding) that the role to be played by purposiveness becomes problematic. Purpose appears to resist mechanistic explanation and is therefore a major impediment to unifying science under one set of principles. Kant concludes that although organisms cannot be explained mechanistically, the impossibility is due to a limitation of reason.¹ By appealing to the critical turn Kant thus avoids an antinomy between mechanism and finality while allowing that it is possible for mechanism and finality to be reconciled in the supersensible. This reconciliation, unfortunately, we will never know.

With the rise of both quantum physics and the theory of relativity, twentieth century science has witnessed the corresponding decline in the primacy of mechanism. Much has been written, for example, of the relationship between Kant's views of space and time and the development of non-Euclidean geometries. Nonetheless, it

¹ Whether Kant was fully converted to the Newtonian camp or, on the contrary, Leibnizian strains remained throughout Kant's writings is a problem outside the scope of this paper, which takes as its starting point the commonplace view that in his critical writings, at least, Kant accepts Newtonian mechanics. For interesting examinations of that issue, see Lewis White Beck, *Early German Philosophy: Kant and His Predecessors* (Cambridge, Mass.: Harvard University Press, 1969); R. S. Westfall, *Force in Newton's Physics: The Science of Dynamics in the Seventeenth Century* (New York: American Elsevier, 1971).

is not erroneous to state that, for the most part, philosophers today are ignorant of current breakthroughs in science.

In 1967 Ilya Prigogine's theory about dissipative structures in chemical reaction systems was empirically confirmed. These structures are identified by their adherence to a principle of "order through fluctuations"; they also exhibit *autopoiesis*,² a particular type of autocatalysis responsible for the self-renewal and self-regulation of living systems. Many scientists working in this field are hailing the principle of order through fluctuations, for which Prigogine was awarded the Nobel prize in 1977, as a new paradigm for science.

It is therefore in the Kantian spirit of articulating concepts that appear in both science and philosophy that this essay attempts to compare Kant's views on teleology as self-organization and the concepts he associates with it (such as non-linear causality and evolution) with those found in the theory of dissipative structures. Whether Kant's theory of finality is a holistic or a systemic one will also be discussed.³ The paper will not, however, attempt to examine whether Kant's conception of evolution is adequate. Nor will this paper attempt to resolve the tension that exists between, on the one hand, the Second Analogy of the first *Critique* in which Kant argues for the unidirectional irreversibility and necessity of causality, and, on the other, Newtonian mechanics, according to which any state can precede as well as follow another. Certain implications of the Second Analogy with respect to organisms and self-organization will be noted; a detailed investigation of this issue is, however, beyond the scope of this paper.

I will first summarize Kant's and Prigogine's views with respect to self-organization and related issues such as evolution, the concept of "life," and freedom. I close with a discussion, on the epistemological/ontological status of self-organization, in which I suggest that Kant relegates teleology to regulative judgment only because its peculiar form of recursive causality "unknown to us" could not

² The term, from the Greek for "self-production," was coined by Humberto Maturana in 1973.

³ Unless otherwise noted, references to Kant indicate "The Critique of Teleological Judgement," in *The Critique of Judgement*, tr. J. C. Meredith (Oxford: Clarendon Press, 1980). These references will also cite, after 'Ak.', volume and page number in Kant's *Gesammelte Schriften*, prepared under the supervision of the Berlin Academy of Sciences.

be subsumed under a (mechanical) causal rule and therefore, according to the Second Analogy of the first *Critique*, could not be awarded constitutive status. Nothing in Newtonian physics could provide such a rule, but perhaps Prigogine's theory of dissipative structures can.

I

Things of objects, according to Kant, possess two kinds of objective finality, relative and intrinsic, the former pertaining to the object's adaptability as a means in the pursuit of other ends, the latter issuing from the relation in which a cause stands to its effects. Those natural things possessing merely relative (objective) finality Kant calls *extrinsic physical ends*: both sandy soil, which is favorable for the growth of pine trees, and rivers, whose course and alluvial deposits benefit the growth of plants (which in turn benefit man), are offered as examples. An *intrinsic physical end*, in contrast, is such that it is "both cause and effect of itself."⁴ As an example of an intrinsic physical end Kant cites a tree: "in the genus, now as effect, now as cause, continually generated from itself and likewise generating itself, it preserves itself generically."⁵ Growth as well as maturation is an example of this particular type of recursive causality. The tree develops itself "by means of a material which . . . is its own product";⁶ thus the preservation of one part depends on the preservation and production of other parts. A tree's leaves, for example, not only are produced by but also maintain the tree. It is this type of causality, *wherein a physical end is both cause and effect of itself, that is properly termed final*. Only organisms exhibit finality, and they do so in virtue of their self-organizing capability, Kant maintains.

To consider an organism as a physical end, the first condition "is that its parts, both as to their existence and form, are only possible by their relation to the whole."⁷ Although the principle of finality is derived from experience, the idea which determines it incorporates all that is contained within it, and it is in that sense *a priori*. And herein lies the unity of the organism, for by being re-

⁴ Kant, p. 18 (§64, Ak. V, 371).

⁵ Ibid.

⁶ Ibid.

⁷ Kant, p. 20 (§65, Ak. V, 373).

ciprocally cause and effect of the whole, the parts form a *unity* and not just an *aggregate*. Since they are produced by and yet, in turn, produce the whole, each part exists in virtue of the agency of the others and the whole and, in turn, exists for the sake of the others and the whole. “Only under those conditions and upon those terms can such a product be an *organized* and *self-organized* being, and, as such, be called a *physical end*.”⁸

These considerations give rise to Kant’s conviction that natural organisms cannot be understood according to mechanism in general or causality in particular. By “mechanism” I mean Newtonian mechanics, and in particular the second law of mechanics, which states that a body tends to remain in its state of rest or motion unless acted upon by an *external* cause. The causality discoverable by the Understanding, the mechanistic causality according to which science must proceed, is linear and contingent, because “the existence of certain things, or even only of certain forms of things . . . [are] only possible by means of something else as their cause.”⁹

The unity of principle found in organisms and evidenced in the growth, maturation, and evolution of their form is therefore not explicable through “mere mechanism” because the representation of organisms exhibits an absolute unity that “the material, [which is] a plurality of things,”¹⁰ does not afford. The causal connections involved in intrinsic physical ends, unlike the unidirectional causal relation described in the Second Analogy of the first *Critique*, “involve regressive as well as progressive dependency,”¹¹ and are *a priori* in the sense mentioned earlier. An organism is not a machine and therefore cannot be understood mechanistically precisely because a machine lacks formative power, that is, it neither produces nor reproduces itself, nor does it self-organize. “Organization” and its cognates such as “organism,” Kant notes, refer to a structure wherein a member is not only a means but also an end; it both contributes to the whole and is defined by it.¹² No machine exhibits this kind of organization, for the efficient cause of a machine lies “outside” the machine in its designer, and its parts do not owe their

⁸ Kant, p. 22 (§65, Ak. V, 373).

⁹ Kant, p. 116 (§87, Ak. V, 448).

¹⁰ Kant, pp. 25–26 (§5, Ak. V, 337).

¹¹ Ibid.

¹² Kant, p. 23 (§65, Ak. V, 375).

presence to each other.¹³ A machine, unlike an organized being, exhibits solely *motive* power.¹⁴

What we find anticipated in Kant is a rudimentary systems theory, the recognition of a systemic level of organization with emergent properties that cannot be reduced to an understanding of the components alone. And indeed Kant uses the terms *systems* and *aggregate* in the first introduction to the *Critique of Judgement* and elsewhere. Finality, Kant suggests, is a systemic property; whereas the workings of the components may be understood mechanistically, the system *qua* system cannot.

Although the concept of a "system" is well-known to philosophers, dating at least to the ancient Greek, *systema* (from *syn-his-temi*, "to cause to stand together"), there have been few attempts to integrate philosophers' understanding of the concept with that developed by Ludwig von Bertalanffy which has come to be known in management science and operations research circles as "general systems theory," the study of systems *qua* systems.¹⁵ Mario Bunge is the only philosopher of whom I am aware who examines ontological questions as well as the mind-body problem from the point of view of general systems theory. Before turning to the theory of dissipative structures, then, let us compare Kant's position with the work of Mario Bunge in "ontological metasystematics."¹⁶

Bunge distinguishes between systems and aggregates on the basis of an *integrity* or *unity*, which is present in the former but not the latter, and which is provided by the system's *structure*. A system has both an *internal* and an *external* structure, the former consisting in the relations among the components, the latter of the relations between the components and the environment. Together, these constitute the *total* structure of the system. *Links, connections, bonds, or couplings* constitute specific types of relation wherein the relation "makes some difference to its relata,"¹⁷ i.e., at least one acts on the other. This description is remarkably similar to the eigh-

¹³ Kant, p. 22 (§65, Ak. V, 373).

¹⁴ Ibid.

¹⁵ Nicholas Rescher's *Cognitive Systematization* (Totowa, N.J.: Rowan and Littlefield, 1979) is one of the few studies to attempt a "cognitive metasystematics," as he calls it.

¹⁶ Mario Bunge, *Ontology II: A World of Systems* (Dordrecht: Reidel, 1979).

¹⁷ Bunge, *Ontology II*, p. 6.

teenth century's construal of the term "purposiveness"; as Cassirer points out in his study on Kant, "a totality is called 'purposive' when in it there exists a structure such that every part not only stands adjacent to the next but its special import is dependent on the other."¹⁸

A system's *structure* is identified by the set of these bonds, links, etc. (its bondage), and must not be confused with the system's *spatial structure*, or configuration. The latter consists in the spatial relationship among the system's components, and is not identical to *shape* since social systems, for example, have no shape but have spatial configuration. Whereas aggregates or assemblages have spatial structure, *they lack system structure*, i.e., they lack bondage. That is why an aggregate may have shape but no *form* in the classical sense.

Clearly Kant's concern in the "Critique of Teleological Judgment" is with *system structure* and in particular with *self-organized system structure*, which has several peculiar properties, the most salient of which is that components are both cause and effect of the whole. There are times, however, when Kant seems to be referring to spatial structure, or even shape. The reason for this apparent reference is that only in the case of organisms is system structure uniquely displayed in the organism's configuration, in its growth and maturation as well as in its heredity and evolution. Indeed, the overarching characteristic of growth as well as evolution is an increase over time in the degree of coordination of the organism. In any organism each subsystem is minimally cohesive—sufficiently only to maintain its integrity—in order to serve the system as a whole by providing maximum coordination at the organismic level.

Is Kant really a holist? "Holism" has acquired such a plethora of meanings that one must first clarify precisely what is meant. Bunge, while lauding systems theory for its recognition that there are emergent properties at the systemic level (something atomism does not recognize), disparages what he labels "holism" for its failure to recognize that systemism arises out of components and their interrelationships. "Holism," he charges, concentrates solely on the molar level as if it were not made up of parts. Furthermore, he accuses holism of holding that:

¹⁸ Ernst Cassirer, *Kant's Life and Thought*, tr. James Haden (New Haven: Yale University Press, 1981), p. 287.

1. *The whole precedes the part.* That is not so, Bunge maintains; a system succeeds its components during the formation of the system; it is only when it is dying or decaying that the decomposition of the whole precedes that of the parts.
2. *The whole acts on its parts.* Wholes cannot act on their parts, according to Bunge. To think they can is a category mistake, for since a level of organization "is not a thing but a set and therefore a concept . . . levels cannot act upon one another. In particular the higher levels cannot command or even obey the lower ones. All talk of inter-level action is elliptical or metaphorical."¹⁹
3. *The whole is more than the sum of its parts.* This is true only if all it states is that a system has emergent properties, i.e., is not merely an aggregate. Any other meaning for "more than" is absurd.
4. *Wholes emerge under the action of agents that transcend both the actions among the components and the environmental influences.* Bunge rejects transcendent entelechies or other such principles but allows to science "a principle of immanence . . . namely this: 'Only the components, the way they come together, and the environment determine what kind of thing a totality shall be'." ²⁰
5. *Totalities cannot be explained by analysis.* According to systems theory this claim is true only insofar as decomposition into parts reveals only a system's composition, not its structure.
6. *The whole is better than any of its parts.* "We shall waste no time on this figleaf," Bunge scoffs.²¹

So is Kant a holist according to Bunge's definition of "holism"?

1. *The whole precedes its parts.* Kant's emphasis on recursive causality, wherein the parts are both cause and effect, precludes the existence of a preexisting whole. The whole is "contained

¹⁹ Bunge, *Ontology II*, pp. 13–14. Not only many biologists but also a number of systems theorists disagree with Bunge on this point. See H. H. Pattee, ed., *Hierarchy Theory: The Challenge of Complex Systems* (New York: George Braziller, 1973).

²⁰ Bunge, *Ontology II*, p. 40.

²¹ *Ibid.*, p. 41.

in them, as a guiding principle,” Cassirer states.²² But it is true that in Kant it is the “representation” or “conception” of the whole that is used to cognize the systematic unity of the organism. So even if the whole lacks logical or ontological priority, it may have epistemological priority, which even Bunge acknowledges, for he notes that often the *identification* of the totality precedes the disclosure of its components.²³

2. *The whole acts on its parts.* Although Kant does speak of causality among subsystems when he refers to the preservation of one part depending on the preservation of other parts, he also uses language that suggests inter-level (top-down) causality (of a peculiar recursive sort). For example, he characterizes the power of an organized being as being such that “it can impart [formative power—organization] to material devoid of it.”²⁴ Cassirer notes that this new type of unity “is regarded not as if it were made up of its parts, but as if it were itself the origin of those parts and the basis of their concrete determinateness. . . . [It is] a type of actuality proceeding not from plurality to unity but from unity to plurality, not from the parts to the whole but from the whole to the parts.”²⁵ That Kant has some type of self-causation in mind is reinforced by his distinction between works of art and organisms. The former point to an extrinsic cause “distinct from the matter, or parts”;²⁶ the latter “combine of themselves into the unity of a whole.”²⁷ Whereas artworks are seen as designed, organisms are not: “We only *read* this conception *into* the facts as a guide to judgement”;²⁸ but we cannot *prove* that organisms require for their production a designer. Kant does not claim, in other words, that “wholes emerge under the action of agents that transcend them.” These wholes *self-organize*. To that extent Kant agrees with Bunge that the principle is immanent in nature: the finality is objective, not subjective. But since Kant cannot find in Newtonian me-

²² Cassirer, *Kant's Life and Thought*, p. 335.

²³ Bunge, *Ontology II*, p. 43.

²⁴ Kant, p. 22 (§65, Ak. V, 374), emphasis added.

²⁵ Cassirer, *Kant's Life and Thought*, p. 335. More will be said on this “principle of primordial organization” below.

²⁶ Ibid.

²⁷ Ibid.

²⁸ Kant, p. 53 (§75, Ak. V, 399).

chanics a rule according to the Second Analogy of the first *Critique* which would render the order of appearances *constitutive*, the inter-level causality implicit in self-organization is relegated to the realm of reflective judgment only.

3. *Totalities cannot be explained by analysis.* As mentioned earlier, according to Kant organisms cannot be understood mechanistically; mechanism and its version of causality cannot provide the “unity of principle” present in the idea of self-organized beings. Kant would therefore reject even Bunge’s narrower claim that a *weak reductionism* which adds “subsidiary hypotheses and data concerning interactions among components”²⁹ can explain form. “Strictly speaking,” Kant says, “the organization of nature has *nothing analogous to any causality known to us*.”³⁰ He has not thereby abandoned the conclusions of the first *Critique*, however. The principle of finality *complements* the causal principle. Although mechanics cannot explain organisms (“[it] speak[s] instead of ‘masses’ and ‘mass-points’ ”³¹), finality “points out the appearances and the problems to which the causal principle should address itself.”³² The principle of finality paves the way for a more comprehensive application of mechanism. Kant, therefore, is no incompatibilist regarding mechanism and finality. His resolution to the antinomy between causal and teleological explanations is to locate the former in the determinate judgment and the latter in the reflective judgment. The reason for locating teleology in the reflective judgment is that the non-linear causality exhibited by self-organization is unlike “any causality known to us.” Were these appearances of non-linear causality capable of being subjected to a “rule,” according to the Second Analogy of the first *Critique* it would then be necessary to award them constitutive status, but this would entail acknowledging that Newtonian mechanics is not the definitive science. We will return to this issue at the end of the essay.
4. *The whole is more than the sum of its parts.* Kant seems to be in complete agreement with Bunge on this issue, for it is

²⁹ Bunge, *Ontology II*, p. 42.

³⁰ Kant, p. 23 (§65, Ak. V, 375), emphasis added.

³¹ Cassirer, *Kant's Life and Thought*, p. 343.

³² Ibid.

precisely the distinctive molar properties resulting from the peculiar kind of recursive causality that provide finality with its distinctive character.

5. *The whole is better than any of its parts.* We find in Kant an indirect connection between a self-organized whole, *qua* end, and value judgments. Although organisms are ends of nature and not practical ends, physical ends open the door to an examination of ends in themselves. The distinction between “purposiveness” and “purpose” is important in this regard. The former, Cassirer notes, means “nothing other than individual creation, which displays a unified form in itself and in its structure,” whereas “purpose” means

the external determination which is allotted to it. [Thus] a purposive creation has its center of gravity in itself; one that is goal-oriented has its center external to itself; the worth of the one resides in its being, that of the other in its results.”³³

“Purpose” applies to extrinsic physical ends; “purposiveness” to intrinsic physical ends. Although the idea of *self-purpose* is, strictly speaking, “restricted to the sphere of the ethical . . . it possesses a symbolic counterpart in the phenomenon of the organism.”³⁴ The universal order realized in/by moral behavior is an integrated whole where each component both contributes to and is determined by the whole. Kant’s kingdom of ends is characterized in language similar to that describing self-organized beings. And, *pace* Bunge, this state of affairs would most emphatically not be an excuse for “suppressing the rights of individuals”³⁵ but rather would require an articulation between component and system (man and society) that would ensure the enhancement of both. Organisms are not *better* than their components, but finality, which characterizes the idea of a system, leads to the ideas of freedom and autonomy which are the subject matter of ethics.

II

After a brief summary of Prigogine’s ideas, in this section I compare the views of Kant just described with those found in the

³³ Cassirer, *Kant’s Life and Thought*, p. 312.

³⁴ *Ibid.*, p. 340.

³⁵ Bunge, *Ontology II*, p. 41.

theory of dissipative structures. The following topics will be examined: *Evolution, God, Life, Self-determination, and Epistemology versus ontology*.

The laws of thermodynamics developed in the nineteenth century could be considered the “rule” required by the Second Analogy, under which the order of appearances can be subsumed, thus providing them with constitutive status as well as giving an account of irreversibility, something Newtonian physics was unable to do. Whereas Newtonian mechanics permits the reversibility of causation, according to thermodynamics all processes exhibit an irreversible tendency towards increasing disorder, ultimately terminating in equilibrium, a state characterized by the complete lack of energy potential—the death of the system.

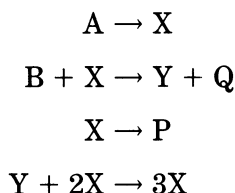
Thermodynamics, however, deals with closed, isolated systems, and cannot account for living systems, which are open and permit the free exchange of energy with the environment. No process of self-organization as is found in living things is possible according to the principles and laws of thermodynamics. But living systems do tend to increasing order, not disorder, and so apparently violate the second law of thermodynamics. An adult human being exhibits a much more sophisticated level of order than does the undifferentiated blastula a few hours after conception, and evolution is characterized by increasing organizational sophistication rather than dissolution. A final difference between open and closed systems is that an “open state of order may be maintained only [when the internal state of the system is in] non-equilibrium,”³⁶ whereas, as mentioned, classical thermodynamics deals with systems at or near equilibrium.

Ilya Prigogine’s insight was that “non-equilibrium may be a source of order,”³⁷ and that *through non-linear processes a spontaneous formation of self-organization—a higher level of order—can develop in open systems far from equilibrium*. For this to occur a third characteristic must be added to those of openness and non-equilibrium: *autocatalyticity*. *Autopoiesis* refers to the particular form of autocatalyticity present in these dissipative structures.

To understand the concept of autocatalyticity, and in particular, autopoiesis, consider the following chemical reaction sequences:

³⁶ Milan Zeleny, “Autopoiesis, A Paradigm Lost?” in Milan Zeleny, ed., *Autopoiesis, Dissipative Structures, and Spontaneous Social Orders* (Boulder, Colo.: Westview Press, 1980), p. 27.

³⁷ *Ibid.*, p. 28.



Joseph Earley writes,

This sequence of reactions describes the conversion of A and B (the reactants) to P and Q (the products) while X and Y are both formed and destroyed (intermediates). The first three reactions are not remarkable, but the fourth step . . . has the unusual feature of being *autocatalytic*.³⁸

The central feature of autopoiesis is that X, the product of the process, is necessary for the activation of the process itself. Zeleny defines an autopoietic system as

a distinguishable complex of component-producing processes and their resulting components, bounded as an autonomous unity within its environment, and characterized by a particular kind of relations among its components and component-producing processes: the components, through their interaction, recursively generate, maintain and recover the same complex of processes which produced them.³⁹

“Stable periodic oscillations around a stationary state, so-called limit cycle behavior,”⁴⁰ is characteristic of these processes.

Autopoiesis results in the appearance of a *hypercycle* “formed by the intermediary products X, Y, Z”; when there is non-equilibrium the clockwise rotation continues, and this circle not only renews itself continuously, but “as a whole, acts like a catalyst which transforms starting products into end products.”⁴¹ X, which reproduces autocatalytically, keeps the hypercycle going. The hypercycle is the result of the fourth step in the previously mentioned chemical reaction sequence.

An autopoietic system clearly satisfies Kant’s definition of an intrinsic physical end, for it both produces itself and maintains itself as itself, i.e., it maintains its overall identity despite a constant

³⁸ Joseph Earley, “Self Organization and Agency: In Chemistry and Process Philosophy,” *Process Studies*, 11 (1981), p. 246.

³⁹ Zeleny, “Autopoiesis,” p. 5.

⁴⁰ Eric Jantsch, *The Self-Organizing Universe* (Oxford: Pergamon Press, 1980), p. 36.

⁴¹ *Ibid.*, p. 33.

turnover of its components. Because each of the processes that define an autopoietic system necessarily requires the others, the system must be studied as a whole. Isolating each of the processes, i.e., attempting to reduce the whole to its components, produces “nothing more than that: a series of snapshots,”⁴² for the character of the system as a whole “cannot be inferred from the characteristics of its parts.”⁴³

The autopoietic system’s persistent maintenance of its identity despite the constant turnover of its components suggests the presence of a nested series of levels of organization. In a multilevel system, each level includes all the lower ones,⁴⁴ but the laws pertaining to one level are not reducible to those operating at a lower level. Keeping in mind that an autopoietic system is a dynamic system, one finds that the identity of the system *qua* system is given by the meta-stability existing at the level of the whole but which disappears if one focuses on the component level. *A dissipative structure is a pattern at a higher level of order.* It is for this reason that Zeleny suggests that the lesson to be learned from the theory of autopoiesis is “the lesson of holism.”⁴⁵ The non-linear, self-organizing dynamics of the higher order level (the systemic level) are not reducible to the mechanistic functioning of its parts. On the contrary, the “dynamics of the [autopoietic whole] provides the framework for the behavioral characteristics and activities of the parts.”⁴⁶ We have here a clear formulation of one of Bunge’s characteristics of a holistic point of view: that the whole acts on its parts—the dynamics of the higher systemic level determine the functioning of the components at the lower level. Accordingly, reduction to the lower level, Jantsch suggests, is no longer possible.⁴⁷

The function of autopoiesis is primarily that of the self-renewal of the system and for that reason is called *self-referential*. “In contrast, an *allopoietic* system, such as a machine, refers to a function given to it from the outside, such as the production of a specific output.”⁴⁸ The significance of this distinction should not be over-

⁴² Zeleny, “Autopoiesis,” p. 17.

⁴³ *Ibid.*, p. 20.

⁴⁴ Jantsch, *The Self-Organizing Universe*, p. 33.

⁴⁵ Zeleny, “Autopoiesis,” p. 20.

⁴⁶ *Ibid.*

⁴⁷ Jantsch, *The Self-Organizing Universe*, p. 27.

⁴⁸ *Ibid.*, p. 33.

looked considering the popularity of theories attempting to reduce purposive behavior to cybernetics. A thermostat's function, the maintenance of a constant temperature, is "given to it from the outside" by its designer. No thermostat originates that function on its own, nor are some of its parts produced by other parts. In other words, a thermostat exhibits organization but not self-organization, despite its feedback loops.

The parallels with Kant are striking: both organisms and certain chemical reaction systems exhibit a type of non-linear causality whereby the products of the whole in turn produce the whole, and are in virtue of this characteristic said to be self-caused or self-organized. For that reason also, neither can be understood via mechanistic principles alone, and neither is amenable to reduction, because their characterization as organisms and dissipative structures refers to a higher level of organization. I do not mean to suggest that Kant understands dynamical laws and relations to lie outside the scope of mechanics; only that self-organization does. But instead of repudiating the classical physics of Newton as the definitive science, he relegates self-organization to the realm of reflective judgment.

Evolution. It is as a result of the study of self-organization that Kant turns to the subject of evolution. Because observation reveals that many genera of animals share similar characteristics, the hope arises that mechanism might explain organic life by attributing analogy of form to descent from a common ancestry,⁴⁹ and that this development might be traceable to "crude matter." If this could be done, organized beings could then be fully explained through the principles of mechanism, and there would be no need to postulate a teleological order. Kant concludes, however, that since mechanism applies to contingent beings, which owe their existence to an external force, science will be unable to locate a mechanistic source of self-organization, and unless it is able to do this, it will *a fortiori* be unable to account for the finality exhibited by organisms. Every characteristic preserved by heredity and evolution must be understood to possess final causality because consistent self-organization constitutes a principle of unity that could not come about through mechanistic laws, which are contingent in the sense of effecting causal change by means of outside forces, as noted earlier.

⁴⁹ Kant, p. 78 (§80, Ak. V, 419).

The inadequacy of mechanism in explaining the similarity of genera is the basis for the theories of pantheism and Spinozism. Kant's own preference, however, is for *generic preformation* or *epigenesis*, which regards "the productive capacity of the parents, in respect of the inner final tendency that would be part of their original stock, and therefore the specific form, as still having been *virtualiter* preformed."⁵⁰ Its opposing theory, *evolution* or *individual preformation* (Kant dismisses occasionalism straightaway), "excludes all individuals from the formative force of nature, for the purpose of deriving them directly from the hand of the Creator."⁵¹

The difference between epigenesis and evolution, then, is that the latter holds that every characteristic found in individual organisms must somehow have been preformed at the very start of the "world-process"; since every feature is thus thought to have been part of the germ of the primordial stock, evolution holds that the generations are merely *educts*.⁵² Epigenesis, on the other hand, "regards [generations] as *products*"⁵³ by allowing nature an active role "in the continuation of the process." Epigenesis appeals to finality only to explain the original beginnings, and thus has the advantage of "entrusting to nature the explanation of all steps subsequent to the original beginnings,"⁵⁴ as well as the ability to explain the later generation of hybrids, mutations, etc.

Kant, who admits to be following Blumenbach in this regard, is distinguishing between a *principle of primordial organization* and a merely *mechanical formative force of impulse*⁵⁵ that resides in matter and body: the former explains the unity of organization present in heredity and serves as the ground for the similarity found in the various genera of animals, whereas the latter allows individuals some degree of causal efficacy, operating mechanistically, in the particular variations in development. The continuity of self-organization, however, requires an appeal to a primordial generic form.

A parallel distinction between a system's overall organization (what has been called its "system structure" earlier) and its specific

⁵⁰ Kant, p. 84 (§81, Ak. V, 423).

⁵¹ Ibid.

⁵² Kant, p. 83, (§81, Ak. V, 423).

⁵³ Ibid.

⁵⁴ Ibid.

⁵⁵ Kant, p. 86 (§81, Ak. V, 424).

composition also appears in the elaboration of the theory of dissipative structures. The processes which the components of these autopoietic systems undergo provide the system with its identifiable and distinguishable unity, its *organization*; the specific spatiotemporal realization of a system's organization is referred to as the system's *structure*.⁵⁶ This distinction is nothing other than the traditional distinction between *type* and *token*, with organization identifying the type and composition specifying tokens of that type. The important thing to note is that it is organization that provides an autopoietic system with its unity and identifies it as that (type of) process. And it is, of course, an organism's organization that is transmitted in heredity. Variation among individuals of the same species is merely a variation of specific composition, explicable mechanistically.

It is characteristic of dissipative structures to evolve. When a sequence of autopoietic structures occurs, "the internal reinforcement of fluctuations (by autocatalysis) . . . *eventually drives the system over an instability threshold into a new structure*; this abrupt transition represents a qualitative change in the nature of the system, and renews its capability for entropy production."⁵⁷ This occurs as follows:

By regulating the flows of the initial and final products [A and B, P and Q] one can move away from equilibrium and, at a certain critical distance an instability occurs. This threshold marks the point at which the least fluctuation can cause the system to leave its uniform stationary state. When this occurs a fluctuation is amplified and drives the system to some new state, characterized by the coherent behavior of an incredible number of molecules, forming perhaps a moving zone of high concentration of a component—a chemical wave . . . or perhaps a stationary state wherein the chemical reactions maintain their spatial organization.⁵⁸

A level of meta-stability has been reached which is characterized by (1) renewed entropy production and (2) a spatial symmetry break (the emergence of a spatially identifiable pattern). Whereas thermodynamics introduces into physics a break in the symmetry of

⁵⁶ Bunge makes no such distinction.

⁵⁷ Jantsch, *The Self-Organizing Universe*, p. 42.

⁵⁸ Peter M. Allen, and Michele Sanglier, "Order by Fluctuation and the Urban System," in Zeleny, ed., *Autopoiesis, Dissipative Structures, and Spontaneous Social Orders*, p. 110.

time, Prigogine's principle of "order through fluctuations" is characterized by a break in spatial as well as temporal symmetry. These symmetry breaks are also said to be the reason for the irreducibility of one level of organization to the one below it.

That is, dissipative processes self-organize into stable structures which in turn, after reaching a critical stage of non-equilibrium, bifurcate and thus evolve into higher-level meta-stable structures. Even though the processes at the lower level may be highly disorganized and unstable, a process can be meta-stable as long as the fluctuations occurring because of the energy exchange involved in the reaction or diffusion rates are damped by the process. Auto-catalysis, however, amplifies these fluctuations (the "driving force" provided by the hypercycle causes the system to accelerate because of its self-reinforcement), and at a critical size the system spontaneously and abruptly drives itself into a new order, a higher level of organization. Autopoiesis thus necessarily begets a higher level of autopoiesis, and the self-organizing system as a whole evolves.

The hypothesis offered by some scientists is that, instead of explaining evolution by postulating the weeding out of unfit species through chance mutations, it may be possible to understand evolution by means of the underlying homologous dynamics of autopoiesis.⁵⁹ And since many inanimate as well as animate processes exhibit dissipative structure, some authors speculate that a general autopoietic systems theory might yet provide a unified theory of evolution of not only flora and fauna, but also of social systems and even of the cosmos.

Is the theory of dissipative structure really holistic, despite Jantsch's avowal that it is?

1. As mentioned above, modern chemistry does allow that the whole—the systemic level—can make a difference to the activity at the component level.
2. The theory does not postulate a transcendent agency responsible for the principle of order through fluctuations: the principle is explicitly said to be immanent.
3. Totalities cannot be explained by analysis. If by analysis one means decomposition into mechanistically functioning parts,

⁵⁹ Jantsch, *The Self-Organizing Universe*, p. 56.

the theorists of dissipative structures would agree that such reductionism will prove futile. The principle of order through fluctuations, which is non-mechanistic, is necessary to explain the macroscopic order; but explanation is thereby possible.

4. The whole is more than the sum of its parts. There is agreement with Bunge and Kant; no non-material substance is postulated, but an emergent level of properties and laws, with undeniable "ontological parity with antecedent and component structures,"⁶⁰ is recognized.
5. With regard to "The whole is better than its parts," no value judgments are made.
6. With regard to "The whole precedes its parts," no temporal or logical precedence relationship is claimed.

Once again the parallels with Kant are remarkable. For Kant it is the principle of primordial organization, the fundamental generic pattern of self-organization, that explains the unity and similarity found in heredity and evolution, and which is the principle responsible for the inheritance of form found in epigenesis. For Kant the primordial form does not contain within itself the mutations and alterations of evolutionary change. Those are caused by the mechanistic operations of nature. For Prigogine it is the contingent (chance and random) fluctuations provided by the environment that eventually serve as the trigger that causes the system to self-organize into a new level of order. In the theory of dissipative structures, too, it is the principle of order through fluctuations, *operating at the systemic and not the component level*, that describes the homologous dynamics serving as the *explanans* for evolution. The principle of order through fluctuations *is* the rule describing primordial organization, it is claimed.

God. The idea of self-organization is such that it can be thought of as being either *designed (technica intentionalis)* or *undesigned (technica naturalis)*; whereas the latter is "identical with mechanism," the former "is intended to convey that nature's capacity for production by final causes must be considered a *special kind of cau-*

⁶⁰ Earley, "Self Organization and Agency," p. 256.

sality.”⁶¹ *Accidentality*, the version of mechanism put forth by Epicurus and Democritus, accounts for the *technica naturalis* in terms of the relation of matter to the dynamical laws of the physical constituents of form. Kant calls this account of self-organization “manifestly absurd.” *Fatalism*, on the other hand, of which Spinoza is an advocate, accounts for the *technical naturalis* by relating matter to a hyperphysical basis. Despite this postulate of an original Being, fatalism nevertheless falls under the classification of “undesigned teleology” because the teleology is said to proceed, not from the Being’s intelligence, but from its nature. There exist parallel subdivisions of *technica intentionalis*: (1) *hylozoism*, which postulates the existence of animate matter and thereby locates the basis for teleology in the physical realm; and (2) *theism*, which postulates a supraphysical explanation for teleology: an intelligent Being who designedly produced natural ends.

We already noted that *technica naturalis* is ruled out as a possible explanation of natural ends, and so the remaining alternative is to postulate “design,” by which Kant means a “special kind of causality.” Of the two species offered by *technica intentionalis*, since hylozoism is unacceptable, the existence of God must be postulated as the ground for the principle of primordial organization, the original beginning. Teleology thus leads to theology because the concept of self-organization points to a special kind of causality, which in turn causes us to think of a Being acting designedly.

Despite being awakened from his dogmatic slumbers by Hume, Kant’s category of causality, particularly as it applies to organisms, owes more to Leibniz than to Hume. Whereas in an early paper Leibniz argued that only a mechanical explanation can supply us with a *vera causa*,⁶² he later modified his views and suggested that mechanism “cannot suffice.”⁶³ Leibniz’s revised view is that although mechanical principles suffice for explanation of proximate efficient causes, “the origin of this mechanism itself has come, not from a material principle and mathematical reasons alone, but from

⁶¹ Kant, p. 42 (§72, Ak. V, 390–91), emphasis added.

⁶² Gottfried Wilhelm Leibniz, *Philosophical Papers and Letters*, tr. Leroy Loemker (Chicago: University of Chicago Press, 1956), vol. 1, pp. 266–67.

⁶³ *Ibid.*, p. 714.

a higher and, so to speak, a metaphysical source”;⁶⁴ explanation via final causality enters in at this point.⁶⁵

Why does Kant turn to Leibniz? Recall Kant’s early defense of Leibniz’s notion of *vis viva*: mechanism views force as imparted from without onto a passive body; but if substances cannot *act*, “there would be no extension, and consequently no space.”⁶⁶ Despite Kant’s repudiation of these views in his critical writings, when he turns to a consideration of self-organization, one perhaps finds him longing for (but not quite giving in to) the notion of a *vis viva*. Why?

Recall Kant’s frequent mention in the “Critique of Teleological Judgement” that causal (mechanical) explanations are contingent: existents must depend on “something else” as their cause. Leibniz’s notion of force, unlike Hume’s passive “constant conjunction” version of causality, buttresses Newtonian science, which studies acceleration by means of the various “forces” acting on the system under examination. Unlike Newtonian mechanics, however, for which the forces are *external* to the system acted upon, organisms exhibit a *built-in* formative force. Mechanics cannot explain natural ends precisely because of this peculiar kind of self-causation unlike “anything known to us.”

Having discarded hylozoism, Kant acknowledges that teleology involves a “special kind of causality.” A special kind of causality may demand a special kind of cause, but the cause must in any case be external to its effect. Despite his Leibnizian influences, then, Kant’s belief that causality operates by means of *external* forces inclines him towards theism. That is, even though Kant retains a Leibnizian flavor in his understanding of causality as involving force, Humean influences are visible in Kant’s belief that these forces must be external to the object upon which they act. Since in the case of self-organization the effect encompasses much of Nature, the cause must be supranatural: God.

According to Zeleny, “so far we know only that system begets system and autopoiesis begets autopoiesis. We do not observe

⁶⁴ Ibid., pp. 810–11.

⁶⁵ Ibid., p. 780. Note that Leibniz’s emphasis on *explanation* foreshadows Kant’s critical turn: in Leibniz’s pre-established harmony, no substance truly *acts* on another—a substance acts by “unfolding its essence,” so to speak. Leibniz’s talk of causality, then, like Kant’s, is not ontological but epistemological.

⁶⁶ Kant, *Inaugural Dissertation and Early Writings on Space*, tr. J. Handyside (Chicago: Open Court, 1929), p. 9.

'spontaneous generation' of autopoietic unities, . . . and neither are we able to bring them about experimentally";⁶⁷ Zeleny accordingly refuses "to speculate about the origins of the first autopoietic organization and thus of life itself."⁶⁸ The questions (1) "What are the primordial generic forms?" and (2) "What is the formative force of nature?" are among the most difficult confronting scientists even today.⁶⁹

Life. If the dynamics of self-organizing systems underlie many non-living as well as living systems, and if both of these can be understood as exhibiting homologous organization patterns, then the question "What is life?" naturally arises at this point. A thing is often defined as living if it reproduces itself, but the concept of reproduction becomes increasingly vague if one attempts to differentiate it from self-organization of the type discussed here, for the ability of dissipative systems to drive themselves over an instability threshold into a new level of organization mimics the "life-form" exhibited by cell clusters self-organizing into tissues, tissues into organs, and so forth. Metabolism, too, is the biological version of maintenance of overall identity despite change in components. The fact that dissipative processes are not static but dynamic "structures" further complicates the attempt to decide whether these are living or non-living systems.

Kant also recognizes that this is a puzzle to which the concept of self-organization gives rise. Such an "impenetrable" property as self-organization, Kant suggests, might better be described as an *analogue of life*.⁷⁰ On one interpretation of this phrase one might ascribe life to matter itself, an option, as mentioned earlier, which Kant rejects, for hylozoism contradicts the essential nature of matter: "The possibility of living matter," he says, "is quite inconceivable."⁷¹ The other alternative is to postulate that there is a soul "associated" to matter. But what can this mean? Either it collapses into the first alternative or it is simply a *psyche ex machina* which

⁶⁷ Zeleny, "Autopoiesis," p. 25.

⁶⁸ *Ibid.*, p. 26.

⁶⁹ For recent controversial attempts to examine these issues, see David Bohm's *Wholeness and the Implicate Order* (London: Routledge and Kegan Paul, 1980); and Rupert Sheldrake's *A New Science of Life: The Hypothesis of Formative Causation* (Los Angeles: J. P. Tarcher, 1981).

⁷⁰ Kant, p. 23 (§65, Ak. V, 374).

⁷¹ Kant, p. 46 (§73, Ak. V, 394).

as such fails to explain. Unable to resolve this problematic relationship between life and self-organization, Kant returns to his critical program and reminds us that self-organization and finality are merely regulative and not constitutive concepts. What Prigogine's ideas suggest is that Kant did not need to postulate hylozoism at the level of the material constituents; something akin to life may be a property which emerges at the *systemic* level because of the self-organizing principles that operate in both a recursive and a top-down manner.

Jantsch wonders whether the self-organizing and evolving characteristics of dissipative structures demand a redefinition of "life": "Life no longer appears as a thin superstructure over a lifeless physical reality, but as an inherent principle in the dynamics of the universe," he says.⁷² Maturana goes so far as to claim that any realized autopoietic system *is* a living system,⁷³ and Zeleny also puzzles that "the concept of 'life' seems to be broader than conventionally assumed."⁷⁴

Self-determination. It might be objected that whereas Kant speaks of teleology (albeit cautioning that it is merely a regulative principle), the authors who write about dissipative structures and autopoiesis reiterate that neither "a *teleological* (goal-seeking) evolution, nor its modification in the form of a *teleonomic* evolution (goal-seeking via a network of possible pathways) corresponds to the new paradigm of self-organization."⁷⁵ Teleology and teleonomy are understood by scientists to involve the existence of a fixed and final, prefigured goal; teleonomy merely allows a variety of pathways along which the preestablished goal can be pursued. The evolution of self-organizing systems, on the other hand, is said to be open and creative since it determines its own dynamics and direction.⁷⁶

The justification for this claim is the following: although a dissipative structure normally follows deterministic laws,

⁷² Jantsch, *The Self-Organizing Universe*, p. 19.

⁷³ Humberto R. Maturana, "Autopoiesis: Reproduction, Heredity and Evolution," in Zeleny, ed., *Autopoiesis, Dissipative Structures, and Spontaneous Social Orders*, pp. 52ff.

⁷⁴ Zeleny, "Autopoiesis," p. 29.

⁷⁵ Jantsch, *The Self-Organizing Universe*, p. 184.

⁷⁶ *Ibid.*

near the points of bifurcation [at the instability threshold] it is the fluctuations which play an essential role in determining the branch that the system chooses; . . . no "explanation" can ever deduce the unique necessity of finding the system in state C for the particular value of the parameter p .⁷⁷

At each instability threshold at least two possible paths open up. Because the choice the system will make cannot be predicted even in principle, there is an indeterminacy at work in the formation of new structures. The further the system departs from equilibrium, the more numerous are the alternatives from which it can choose. The process, in other words, is said to create itself by determining its own goal and to choose the specific evolutionary route to that goal; dissipative structures are said to be free and open precisely because of this self-determination (sometimes called the system's ability to self-transcend).

Whether the goal in teleology is fixed and pre-established or whether it is an immanent one was a problem Kant, like Aristotle, had to face. Kant was able to avoid committing himself by appealing once again to the critical program. Does Kant posit a predetermined goal? One must recall Kant's rejection of *individual* preformation as implausible and unable to account for hybrids and mutants; nature must be allowed some causal efficacy if one is to understand such alterations. But an ultimate preformation is implicit in epigenesis, for it is this preestablished pattern of organization which explains the similarity of genera, evolution, and heredity. Organization is not a transcendent goal, but rather an immanent principle of primordial organization. But, an objector might insist, an immanent goal is not freely chosen, and so there remains a radical difference between Kant's association of purposiveness with epigenesis on the one hand, and the views of the scientists working in the field of dissipative structures on the other.

But there is in Kant one exception that plays a pivotal role in this connection: the behavior of human beings. As anyone familiar with Kant's ethics knows, in the practical sphere reason must presuppose its own freedom, i.e., its own causality, for morality to be possible. A *final* end, if such exists, must be unconditioned, and only man as an autonomous agent, who freely determines his own ends, can satisfy this requirement. There is no moral dimension in

⁷⁷ Zeleny, "Autopoiesis," p. 114.

organisms other than man, so although organisms *qua* self-organizing exhibit final causality, in them self-organization is a process ultimately patterned according to a principle of primordial organization and therefore is not free.

In the realm of morality, however, there can be no prefigured, fixed goal, immanent or transcendent, for if there were there would be no autonomy and no ethically praiseworthy behavior. It is only this distinction between a human being *qua* organism and a human being *qua* moral being that enables Kant to introduce the idea of freedom. *Qua* organism, the human being is not free, because he is subject to the principle of primordial organization; *qua* moral being, on the other hand, we must postulate his freedom. And so there does remain a difference between Kant's notion of teleology and Jantsch's, for Jantsch, unlike Kant, maintains that although at different levels, other organisms as well as man—indeed all systems functioning according to the principle of order through fluctuations—act according to a homologous dynamics that is free and creative. According to Jantsch it is not only man who is free; *all* dissipative structures at the instability threshold, when choosing among alternative pathways along which to evolve, are free. According to Kant only man is free.

Epistemology versus ontology. The organism's systemic unity has, for Kant, *epistemological priority*. Kant's definition of purposiveness is of a state caused by the *representation* of the state; "it is not the whole but the *concept of the whole* which is the cause of the state of any part."⁷⁸ But throughout, this paper has referred to the theory of dissipative structures as making *ontological* claims. Given that Kant's overriding contribution is the replacement of ontological explanations by epistemological explanations, what real parallels can one draw between Kant and, for example, Prigogine? The waters become quite murky at this point: reading scientific treatises as works in epistemology is a questionable enterprise at best, and analogies can be stretched beyond the point of usefulness. But perhaps something can be said about this issue.

Maturana suggests that an autopoietic system describes a cognitive system. As mentioned earlier, it is in its exchanges with the environment that, as an open system, an autopoietic system renews

⁷⁸ Lewis White Beck, personal correspondence.

itself *qua* itself. In these interchanges the system seems to “know” what exchanges it is necessary to enter into with the environment, i.e., it seems to know what it needs to take in and release in order to maintain itself as itself. Indeed, Jantsch says, if “consciousness is defined as the degree of autonomy a system gains in the dynamic relations with its environment, even the simplest autopoietic systems such as chemical dissipative structures have a primitive form of *consciousness*.”⁷⁹

It may be going too far to suggest that an autopoietic system *represents* a future state of itself to itself, and that this representation causes the future state to occur. The question *this* issue raises, of course, is the old Chomskian problem: What exactly is involved when one postulates that a semantic rule is represented in the system or organism? And it is, according to Jantsch, precisely the semantic that “gets introduced” here:

A cell contains several thousand biochemical processes in a very small volume, and many of them are interlinked by complex, intermeshing feedback loops. . . . [T]he microscopic equivalent of following all these individual processes would require infinite time. . . . However, if one searches for ‘rules of the game’ for all these processes and for criteria of holistic system behavior—in other words, if the semantic level gets introduced—one may hope for a simpler representation.⁸⁰

This quotation is noteworthy because it illustrates the oscillation from ontology to epistemology found in these scientific writings. It is not clear, for example, whether the “introduction of the semantic level” here means that the semantic is simply a more convenient description or that the higher level “rules of the game” apply to a higher ontological level.

Clearly Kant’s claims are epistemological: final causation means for Kant only that *we* cannot think of organisms except as self-organized, not that organisms *are* self-organized. The emphasis on the limits of cognition, not ontology, is the reason for the distinction between regulative and constitutive principles (and is what

⁷⁹ Jantsch, *The Self-Organizing Universe*, p. 40.

⁸⁰ *Ibid.*, p. 41. For a different approach to the same issue, see Lewis Thomas’s *The Lives of a Cell* (New York: Bantam, 1975) for an examination of the ability of certain lower forms of animal life such as lichens to recognize themselves as themselves, as well as to recognize other individuals of the same species as “not themselves.”

keeps the “Critique of Teleological Judgement” firmly inside Kant’s critical work).

Prigogine’s earlier nominalist orientation is similarly worthy of note in this connection: classical physics, he says, is the best description available for the world of Being, where past and present play the same role; its inadequacies, however, particularly with respect to irreversible processes and evolution, are well recognized. Thermodynamics, on the other hand, captures the dynamical domain in which time plays an essential role. The scientist’s task is “not to ‘reduce’ physics and biology to a single scheme, but to clearly define the various levels of *description*, and to present conditions that permit us to pass from one level to another.”⁸¹ After the completion of this essay, Prigogine’s latest work, *Order out of Chaos*, appeared in English.⁸² In this work he is much less tentative and comes out in favor of ontology. “If the positivistic view . . . was accepted, science would lose much of its appeal,” he says.⁸³ He views science as a dialogue with nature. What nature says to us is often brought about by the questions we ask of her. But she is not thereby malleable; she answers back, often by falsifying our theories, that is, by saying “No!” to our questions. Science thus provides us with knowledge of reality.

Whereas in Kant the regulative principle of finality paves the way for a more comprehensive application of mechanism, for Prigogine no one level of description is fundamental. Prigogine’s thesis is that the laws of nature are different depending on the aspect of nature to which they refer: the reversibility of mechanism applies to billiard balls, for example, but not to organisms. There is a point, then, in which no “more comprehensive application of mechanism” is possible, because mechanism works only for one level of reality. Each level of reality requires laws that operate at that level, and although reduction is possible *within* levels, it is not possible *between* levels.

What conclusions can one reach? The question of whether self-organization can be explained mechanistically remains a live question within science. The non-linear, recursive causality responsible

⁸¹ *From Being to Becoming* (San Francisco: W. H. Freeman, 1980), p. xiv., emphasis added.

⁸² (New York: Bantam Books, 1984).

⁸³ *Ibid.*, p. 98.

for the self-organization of organisms is what provides the stumbling block, for self-organization involves varying levels of organization and inter-level causality, particularly from the higher (systemic) level to the lower constituent levels, is a “special kind of causality” that cannot be explained mechanistically; neither can the emergent properties exhibited by the systemic level, for mechanism deals in “mass points” whereas self-organization is a process, as Kant points out in the Second Analogy. Prigogine’s theory purports to provide the scientific theoretic explanation for this phenomenon.

Towards the end of the Introduction to the “Critique of Teleological Judgement” Kant states that teleology is an estimate of the reflective judgment, according to which nature is *conceived* according to ends. This conception is objective—found in nature itself, not ourselves; it is not a product of the imagination. But since the self-organization exhibited by nature “has nothing analogous to any causality known to us,”⁸⁴ since, according to the Second Analogy of the *First Critique*, “we [can] derive the *subjective succession of apprehension* from the *objective succession of appearances*”⁸⁵ only if the latter can be subsumed under “a rule in accordance with which the appearances in their succession . . . are determined by the preceding state,”⁸⁶ although we may *regard* nature as teleological, that is, as acting *technically*,

this is a different thing from crediting nature with causes acting *designedly* . . . [which] would mean that teleology is based, not merely on a *regulative* principle . . . but is actually based on a *constitutive* principle. . . . But in that case the conception would not really be specially connected with the power of judgement. . . . It would, on the contrary, be a conception of reason, and would introduce a new causality into science. . . .⁸⁷

In short:

1. According to the Second Analogy of the first *Critique*, appearances are awarded constitutive status only if they can be subsumed under a rule that shows their irreversibility and necessity;
2. According to the third *Critique*, because causality as characterized

⁸⁴k Kant, p. 23 (§65, Ak. V, 375).

⁸⁵ *Critique of Pure Reason*, tr. Norman Kemp Smith (New York: Macmillan, 1965), p. 221 (B238).

⁸⁶ *Ibid.*, p. 222 (B240).

⁸⁷ Kant, p. 5 (§61, Ak. V, 360–61).

by the second law of mechanics operates on contingent beings, nothing causes itself to change; only external forces can cause a body to change;

3. No “external forces” are present in the self-organization of organisms.

Therefore, self-organization exhibits a causation *sui generis*; since hylozoism is unacceptable, the fact that causality demands an external force requires us to postulate (without proof forthcoming) the existence of God as that external force causally responsible for self-organization. Since no objectively causal rule under which to subsume self-organization can be found that connects organisms with a God who could serve as the external cause of their self-organization, teleology is only a principle of the reflective judgment.

But what if a rule (the Principle of Order through Fluctuations of dissipative structures) has been found, under which the necessary order of self-organization can be subsumed, but which introduces a new, *non-linear, non-mechanical, self-activating* causality into science? What if this rule could explain the recursive causality responsible for self-organization, but violates both (2) above and the requirement of unidirectionality of the Second Analogy? Recall that Kant states in the Second Analogy that the primary contribution of the Understanding is to make representations possible and “[T]his it does by carrying the time-order over into the appearances and their existence.”⁸⁸ A rule that explains the irreversibility of the process of self-organization would satisfy this requirement. The rule that would convey constitutive status to appearances must also show how one event determines the following one “inevitably,” “invariably,” and “necessarily.” Prigogine’s principle cannot do this, for, as we saw, there is an element of indeterminacy and chance at the instability thresholds: there is no “one specific order of perceptions rather than another”—A could be followed by either B or C. But Prigogine *can* explain why B never *precedes* A; the principle explains that irreversibility. The Principle of Order through Fluctuation also explains the self-organization and evolution that its dynamics necessarily bring about. Kant indirectly criticizes Hume, for whom causality is “as contingent as the experience upon which it is based,”⁸⁹ the cause is external to the effect. Prigogine’s principle

⁸⁸ *Critique of Pure Reason*, p. 225 (B244).

⁸⁹ *Ibid.*, B241.

can explain why this contingency does not apply to organisms: these necessarily self-organize according to a particular rule.

Can one say that Prigogine et al., unlike Goethe, refuse to be resigned to Kant's limitations of reason and are attempting to push back its limits by formulating a rule for the special type of causation according to which our representations of "living wholes" must proceed? That is, Does the Principle of Order through Fluctuations provide the rule, and thereby explain why we cannot regard organisms except as "self-organized"? If the principle is successful in doing so, *by Kant's own admission* will the regulative principle of teleology have been converted into a constitutive principle?⁹⁰

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⁹⁰ I would like to thank Lewis White Beck for valuable comments on an earlier draft of this paper.