# ON SOCIAL-BIOLOGICAL HOMOLOGIES

Robert Rosen*

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* Department of Physiology &
Biophysics, Dalhousie University



INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria

FOREWORD

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Boris Segerstahl
Leader
Science & Technology
Program

## I. INTRODUCTION

In the present paper, I will attempt to discuss some recent developments in the epistemology of organisms, and to see what these might mean for the study of social systems.

I believe that biology and the human sciences are closely related in a number of important ways, and that through these relations they have much to learn from each other.

The simplest relation between organisms and social systems is the reductionistic one, that social systems are, at least in part, built of organisms. Thus, the properties of the former cannot help but be influenced by those of the latter. This is merely a further extrapolation of the fact that, since organisms themselves are composed of matter, the properties of matter influence the behaviors of organisms. Indeed, even so microscopic an event as a single electron out of place at the physical level can ramify upward through organism and society to end up in the most dramatic social consequences; a familiar example is the mutation to hemophilia in the Imperial Russian royal line in the late 19th century. However, as we shall see, this reductionistic relation between biology and the human sciences is in many ways the least interesting.

A more profound relation between biology and social systems is the analogy which exists between them. We will define the concept of analogy more precisely in Section II below. It suffices to mention here that this analogic relation was already perceived by Plato, and by political philosophers like Hobbes, as well as by biologists in our own time, and has led to the concept of society as superorganism. The theoretical importance of this kind of analogy, if it can be made precise, lies in the fact that our experiences with organisms and societies are of entirely different kinds. A biologist is always in the position of an external observer, condemned to study only effects of remote causes, at which in most cases he can merely speculate. On the other hand, we are ourselves all part of social organizations; we feel their causal structures acting upon us at every instant; but we cannot for that reason even imagine what an external observer of a social system would be like. Thus, our biological and social experience are almost orthogonal; if we could combine them, through some precise concept of analogy between the biological and the social, both fields would be enormously enriched.

Still another relation between the biological and social sciences arises from the fact that both have so far proved refractory to the kinds of scientific analyses that have been so fecund in the study of inanimate matter. This refractoriness may, as reductionists believe, arise entirely from technical considerations; from the fact that organisms and societies are simply more complicated than inanimate systems. But they do not doubt that the same principles and laws govern all these situations, and that it is only a matter of time until the physical basis of all organic behavior is made explicitly manifest. The other possibility, which we will explore here, is that the conceptual basis of contemporary physics is simply too narrow; its language too empoverished, to allow us to approach organic phenomena effectively from this direction.

Those who have been unhappy with reduction, either of biology to physics, or of social science to biology, usually are so because of the perceived telic characteristics arising at the level in which they are interested, and which they feel are decisive for the behaviors manifested at that level, but which are entirely absent at lower levels. Whether dealing with the free will of humans in social systems, or the tropisms of even the simplest organisms, there seems to be some essential arbitrary, volitional aspect which, by its very nature, must elude the mathematical equations which describe the inorganic world. Thus, both biology and the human sciences are permeated by a common sense that traditional theoretical methods do not in principle capture some essential element of finality or final causation, which is at the heart of their subject matter. On the other hand, it is generally believed that the "hard" sciences (e.g. physics and chemistry) owe their own development precisely to the rigorous exclusion of finality, and therefore that telic considerations must be excluded from science entirely. Thus, both the biologist and the social scientist face a common dilemma: to be scientific, they must eschew finality, but to be biological or social, they cannot.

What I will suggest in the developments to follow is that to be concerned with finality, and to be scientific, are by no means incompatible in biology. The apparent contradiction between them arises from too narrow a view of what constitutes rigorous science; and more precisely, from a few tacit assumptions characteristic of Newtonian mechanics, which have come to permeate all forms of system theory known to me. It is the identification of these with science which has led to the difficulties mentioned above. When these tacit epistemological hypotheses are made explicit, alternative modes of system description become visible, in which categories of final causation can be manifested in an entirely rigorous, non-mystical way.

Before embarking on this, it is instructive to consider briefly the history of the conflict between finality and mechanism in biology; I presume there is a parallel literature in the human sciences. This is essentially a conflict between the Aristotelian view that volition, and hence finality, is at the heart of the distinction between animate and inanimate, and the Cartesian view that there is no such distinction; that the organism, like everything else, is a mechanical device; a machine or gadget. Kant, for example, embraced the Aristotelian position, and clearly perceiving that finality and mechanism (at least in the Cartesian sense) are mutually exclusive, argued that organisms are in principle incapable of being studied by mechanical means. For this reason, Kant argued that there could never be a "Newton of the leaf", who could do for a blade of grass what Newton did for inanimate nature. Among biologists, the most famous finalist was the embryologist Driesch, who on the basis of his experiments on embryonic regulation concluded that no mechanical explanation of his results was possible in principle.

On the other hand, the Cartesian view of the organism as mechanism provided from the outset a powerful unifying hypothesis, as well as a specific clue on how to make biology "scientific". The growing development of physical technology has produced instruments which could be applied to organisms as well as to inanimate matter, and culminated in the present-day field of molecular biology. One of the most articulate modern exponents of the Cartesian viewpoint, Jacques Monod, makes it a postulate (the "Principle of Objectivity") that finalism be excluded from biology as a matter of course (while at the same time, ironically, denying that the main features of biology could ever be deduced from first principles).

On the theoretical side, much attention has been given to the simulation of telic behavior by mechanisms. One example of this was the "open system" metaphor, proposed by von Bertalanffy and others in the mid-thirties. These investigators pointed out that the behavior of open dynamical systems around stable attractors (as we would now say) manifests, of itself, many of the apparently telic features exhibited by organisms, such as adaptability and equifinality. In the process, by the way, they exposed gaping holes in <u>physical</u> theory (especially thermodynamics); holes which have not yet, after half a century, by any means been successfully filled.

An apparently separate development, though formally identical with the open system ideas, arose from the concepts of cybernetics. The capabilities of feedback loops in a physical system to simulate telic behavior was early emphasized by Norbert Wiener. These ideas, and cognate developments in computation, have given rise to the idea of an organism as "programmed complexity" (whatever that means), and this too is incorporated into the current ideas of molecular biology.

The point of all of these developments is thus to argue indirectly that <u>all</u> forms of finality can be manifested by true machines, and hence that finality is a superfluous concept.

The difficulty with such an approach is that cybernetic systems, in the broadest sense, constitute a universal class of simulators, much as the epicycles of Ptolemy were for planetary orbits. And of course, there is a vast difference between mere simulation and scientific understanding. Thus, the simulation of fragments of telic behavior in non-telic mechanisms is no argument in itself, either for or against finality in biology. To investigate the question more deeply, we must see exactly what is incorporated into the very idea of a mechanism; more particularly, we will try to see whether there are real physical systems which are not mechanisms. Thus we will, in a sense, turn the "cybernetic" arguments against finality back on themselves, and argue in effect that the telic systems can simulate machines; but that does not at all mean that they *are* machines.

## II. THE MODELLING RELATION

Our attention will be focused primarily on the class of formal or mathematical systems which may be images of real-world systems, be they atoms or organisms or societies or automobiles; henceforth these will be called natural systems. The nature of this class of presumptive mathematical images of natural systems is of crucial importance, for it determines the entire character of our science. The kinds of mathematical systems in it, and the relations between them, are the arena for confronting most of the deepest scientific problems; the problem of reductionism, for example, involves nothing else. The main thrust of the Newtonian revolution, for example, lay in the fact that it specified such a class (the class of general dynamical systems, or "state-determined" systems), while developments in thermodynamics, and even relativity, served to circumscribe that class.

Since this class of mathematical images of natural systems is so important, we shall briefly describe how it arises, and why it plays such a central role.

Our belief in natural law, without which science would be futile, and our daily lives unlivable, has two complementary facets. On the one hand, we must believe that the successions of events which we perceive in the external world are not entirely whimsical, arbitrary or chaotic, but manifest some definite relations. Relations between events in the external world collectively constitute what we call <u>causality</u>. Thus, a belief in causal relations between events constitutes one essential aspect of our belief in natural law.

The other facet, different but equally important, is that we believe the causal order can be, at least in part, grasped and articulated by the human mind. This means that the causal order relating events can be translated into a corresponding order between propositions describing events. But such propositions belong to a different world than the events themselves; a symbolic, linguistic world. There is thus no question of a "causal" order between such propositions. But there is another kind of order in this symbolic, formal world; a logical or implicative order, which allows us to generate new propositions (inferences or theorems) from given ones (hypotheses or premises).

Thus, our belief in natural law ultimately boils down to this: that the causal order relating events can be brought into congruence with some kind of implicative order in an appropriate formal or symbolic system describing these events. Once the congruence has been established, theorems in the formal system translate into predictions about the causal order in the real world.

A relation of congruence between the causal order in a natural system, and the implicative or logical order in an appropriate formal system, will be called a <u>modelling relation</u>.

We can sum up this discussion concisely in a diagram as follows:

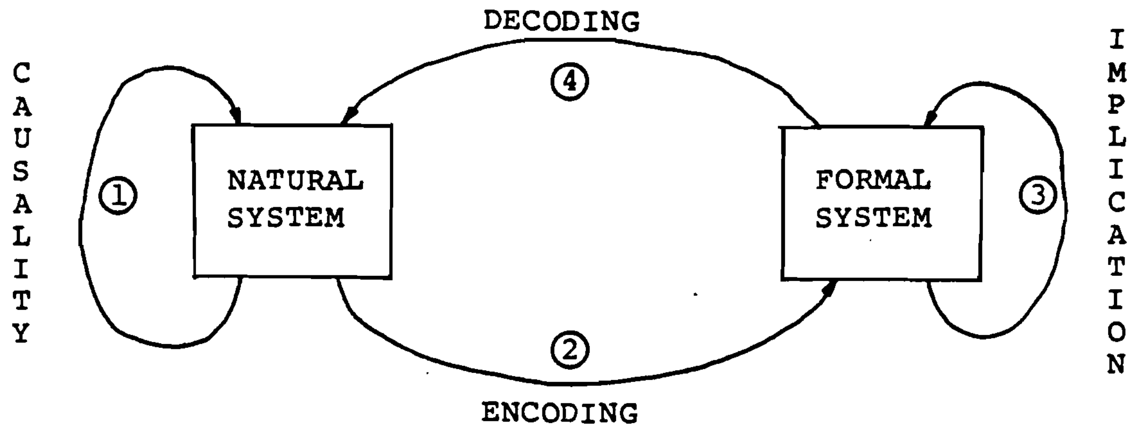


Figure 1
The Modelling Relation

In this diagram, a natural system in the external world, and a formal system are to be brought into congruence. The crucial features in establishing the congruence are the arrows (2) and (4) in the diagram, which we have labelled "encoding" and "decoding" respectively. These arrows represent a kind of dictionary, whereby events in the natural system are represented by appropriate elements of the associated formal system, and whereby such elements can be decoded back into events. The modelling relation obtains when the diagram commutes; i.e. when

$$(1) = (2) + (3) + (4)$$

In this case, one always obtains the same answer, whether one simply looks at or observes the causal order in the natural system (i.e. the arrow (1)) or whether one encodes into the formal system (the arrow (2)), employs the inferential structure of that system to generate new propositions (the arrow (3)) and decodes these to generate predictions about the natural system (the arrow (4)).

There are many important ramifications of this basic diagram, which we have described in great detail elsewhere. We will briefly describe one of them, for it underlies the concept of analogy between structurally diverse systems. Imagine that two such systems have been put into a modelling relation with a common mathematical image or model. Then we have a diagram of the form

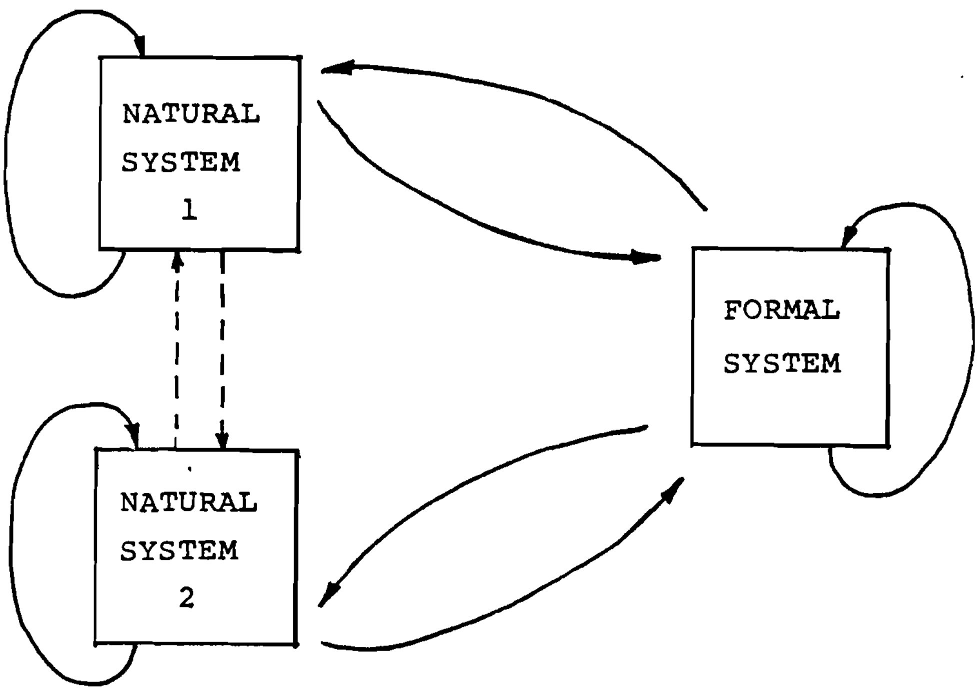


Figure 2

We can use the fact that dictionaries exist to convert the causal structures of both natural systems into the inferential structure of a common formal system. This allows us to establish a new dictionary, relating the causal structures of our natural systems. Indeed, if we just look at the left-hand side of the diagram of Figure 2, we see that it looks essentially like Figure 1, except that it relates two natural systems, instead of a natural system and a formal one. It thus establishes something like a modelling relation, but between two natural systems. This relation is what I call analogy. In other words, two natural systems, whatever their physical structure may be, are analogous to the extent that they share a common model, or realize a common model. The word "analogy" is used here as a generalization of "analog computation", which is precisely of this character. So too are the familiar ideas of similarity and scaling, which dominate many areas of physics, engineering, and increasingly, biology.

For present purposes, we are concerned only with the class of formal systems which can sit on the right-hand side of this kind of diagram; i.e. those which can be models of natural systems, or, in another language, which can be realized by natural systems. We shall now turn to the description of such a class, originally postulated implicitly by Newtonian mechanics, but nowadays taken as the universal class for natural system description. We shall call this the class of simple systems, or mechanisms. As we shall see, the mandating of this class involves some extremely strong hypotheses about the natural world, which have never been stated explicitly, and which need not be true. Then we shall see what happens when we modify these hypotheses; i.e. enlarge the class of mathematical images.

## III. MECHANISMS: THE NEWTONIAN PARADIGM

As noted above, Newtonian mechanics posited above all a universal mode of natural system description. That is, it stipulated a canonical means of encoding any natural system into a definite sort of formal, mathematical model, and decoding the theorems of that model into predictions about the natural system. Thus, Newton posited not only a class of presumptive mathematical models, but equally important, the encoding and decoding which turns a formal system into a model.

The influence of Newtonian mechanics has since radiated in two distinct directions: a reductionistic direction and a paradigmatic direction. Mechanics itself was initially concerned only with the dynamics of systems of material particles. Such particles idealized the concepts of the pre-Socratic atomistic philosophers, who argued that reality consists of multitudes of indivisible (hence structureless) particles or atoms. Insofar, then, as any natural system could be analyzed into its ultimate atoms, and insofar as these ultimate atoms could be described in Newtonian terms, then any scientific problem becomes a mechanical one; this is a strong form of reductionism. On the other hand, it came to be recognized that the language of dynamical systems could encode properties of natural systems (e.g. ecosystems) directly, without waiting for a true reduction into the ultimate particulate language; this is the paradigmatic aspect of mechanics.

The essence of the mathematical language, first developed by Newton to deal with systems of mass points, and later extended to a universal mode of system description, is the dualism between states and dynamical laws. In mechanics itself, this takes the form of a dualism between phases and forces. Roughly speaking, the phases or states pertain to what is intrinsic to the system, while the dynamical laws describe the effect of the environment on the system.

Any natural system may have a multiplicity of descriptions, or models, of this type. But, insofar as any natural system is reducible to a system of structureless particles, among these descriptions there will be a biggest one, from which all others can be obtained (i.e. which maps effectively onto all the others). This is the strongest form of reductionism, which as noted earlier, is a postulated mathematical relation stipulated to hold among a class of models or mathematical images of any natural system. This ultimate mathematical description is thus not an abstraction; it contains in itself all the information manifested in every other description, and incorporates explicitly every aspect of reality of the natural system with which it is associated. In this picture, then, the solution of every scientific problem is reduced to the technical ones of constructing the ultimate description, and extracting from it the appropriate information.

We shall call a natural system admitting such an ultimate description as a model, and all of whose partial or phenomenological descriptions are also of this type (i.e. manifesting the characteristic dualism between states and dynamical laws superimposed on them) a <u>simple system</u> or <u>mechanism</u>. The motivation for this terminology will become clear as we proceed. The upshot of the Newtonian picture, then, is that <u>every natural system is a mechanism</u> in this sense.

As we have noted, it has since become "self-evident" that this language is the universal vehicle for system description. However, we shall now view the entire situation from another angle; from this it will become clear that this "self-evident" language actually involves a number of tacit hypotheses which may not be true.

What we will do is to compare the Newtonian picture with the old Aristotelian categories of causality. The Newtonian picture, as we said, always involves the postulation of a state set, once and for all, and the superimposition on this manifold of states of a set of dynamical laws; the mathematical image of a natural system is thus some technical variant of a dynamical system:

$$d\vec{x}/dt = \vec{f}(\vec{x}, \vec{\alpha}, \vec{\beta}(t)) \qquad (1)$$

Here the vector $\vec{x}$ is a state vector; the vector $\vec{\alpha}$ is a vector of structural or constitutive parameters, and the vector $\vec{\beta}(t)$ allows a time-dependent set of "forcings" or "inputs" or "controls" to be incorporated.

Mathematically, the dynamical law is a local relation between a velocity vector $d\vec{x}/dt$, the rate of change of state, and the state itself, modulated by what we have called parameters and controls. However, its significance is that it can be converted to a mathematically equivalent but epistemologically completely different kind of statement, by a process of integration:

$$\vec{x}(t) = \int_0^t \vec{f}(\vec{x}(0), \vec{\alpha}, \vec{\beta}(\tau))d\tau \qquad (2)$$

More specifically, the dynamical laws pertain to the values assumed by magnitudes at single instants; the integrated form of these laws pertain to values assumed at different instants. The integration process can be viewed as a continuum of theorems all inferable from initial conditions as hypotheses, and each of these theorems is a prediction about the associated natural system.

If we now think of x(t) as effect, then in the Aristotelian parlance, we can put:

1. $\vec{x}(0)$ is material cause;

2. $\vec{\alpha}$ is formal cause;

3. The operator $\int_0^t \vec{f}(\ldots, \vec{\alpha}, \vec{\beta}(\tau))d\tau$ is efficient cause.

Thus three of the four Aristotelian categories of causation are imaged in the Newtonian scheme. We now make three crucial observations about this situation:

a. There is no category of final causation visible. Indeed, the Newtonian picture has no room for this causal category; it cannot accommodate finality without complete collapse. In modern language, final causation amounts to anticipation; the dependence of present change of state upon future state or future input. It is precisely because of the presumed universality of the Newtonian language, and its identification with science generally, that final causes are excluded from scientific discourse, on the ironic grounds that they "violate causality".

b. The categories of causation, as manifested in the Newtonian scheme, are in general inequivalent. By this we mean the following: in (2) above, we could imagine replacing a given initial state $\vec{x}(0)$ by a perturbed one, $\delta\vec{x}(0)$; or an initial vector $\vec{\alpha}$ of constitutive parameters by a perturbed one, $\delta\vec{\alpha}$; or a vector $\vec{\beta}(t)$ of controls by a perturbed one, $\delta\vec{\beta}(t)$. Each of these would lead to some change $\delta\vec{x}(t)$ in the effect $\vec{x}(t)$, which we can say would follow from a perturbation of material, or formal, or efficient cause respectively. The causal categories would be equivalent if each $\delta\vec{x}(t)$ could be produced by some $\delta\vec{x}(0)$ alone (i.e. by some variation in material cause), and by some $\delta\vec{\alpha}$ alone (i.e. by some variation in formal cause), <u>and</u> by some $\delta\vec{\beta}(t)$ <u>alone</u> (i.e. by some variation in efficient cause). Or what is the same thing, any variation in any category of causation could be annihilated or offset by corresponding variations in the other categories. Mathematically, the question of the equivalence of the categories of causation in the Newtonian context is basically one of structural stability.

The inequivalence of the causal categories has, by itself, numerous interesting ramifications, some of which we have explored in some detail elsewhere. It is, of course, perfectly consistent with the Newtonian picture, but it is obscured in that picture by the standard practice of treating all observables or variables, including parameters, as simply arguments of mathematical functions, from which the basic operational distinctions between them have been abstracted away. It is for this reason that many positivistic philosophers of science (notably Bertrand Russell) could argue plausibly that causality was an obsolete and unscientific concept, which was never used in an "advanced science" like "gravitational astronomy". More precisely, these individuals tacitly accepted that the encoding and decoding arrows in Figure 1 above were completely specified by the Newtonian scheme and thus need not be considered further; they thus concentrated their attention exclusively on the mathematical images resulting from these encodings.

c. In the Newtonian picture, the categories of causation are isolated into discrete, disjoint mathematical structures. For instance, the very concept of a state space splits off the notion of material cause from the other causal categories. Likewise, the notion of formal cause is split off into some kind of "parameter space", and the notion of efficient cause is segregated into a parameterized family of operators. It is thus possible to modify any one of these causal categories without affecting the others. Indeed, there are no "laws of nature" known to me which place any limitation whatsoever on the independence of the causal categories as manifested in the Newtonian scheme.

It is this last feature which is decisive. In fact, I will argue that the Newtonian picture entails the independence of the causal categories, and is essentially equivalent to it. When we put it this way, however, it is obvious that the Newtonian paradigm completely loses its "self-evident" and universal character, and the special nature of the simple systems, or mechanisms, which it describes is made clearly manifest.

To leave the Newtonian paradigm, then, is to allow system properties to simultaneously manifest themselves in several categories of causation. We will now briefly describe one way in which this can be done.

## IV. TOWARDS A CATEGORY OF COMPLEX SYSTEMS

As we have seen, if we wish to leave the category of simple systems, or mechanisms, which are characterized by the Newtonian paradigm, it suffices to render the causal categories interdependent. In this section, we shall sketch one way this can be done (perhaps not the only way), and explore some of the consequences of this process for the problems at hand.

My own first excursion out of the Newtonian universe came about as follows. Given a traditional set of dynamical equations, of the form (1) above, we can think of forming the new observable quantities

$$u_{ij}(\vec{x}, \vec{\alpha}, \vec{\beta}(t)) = \partial/\partial x_j (dx_i/dt) \qquad (3)$$

where $x_i$, $x_j$ are arbitrary components of the state vector x. These quantities play an important role in the stability analysis of (1), not so much in their numerical values, but in their signs. If $u_{ij}$ is positive in a state, it means by definition that an increase in $x_j$ will increase the rate at which $x_i$ grows (or equivalently, a decrease in $x_j$ will decrease the rate at which $x_i$ is growing). Thus it is natural to say that $x_j$ is an activator of $x_i$ in that state. Likewise, if $u_{ij}$ is negative, we can call $x_j$ an inhibitor of $x_i$ in that state. The main interest of this terminology is that "activation" and "inhibition" are informational terms, and it seemed possible in this way to begin to build a dictionary between physical systems, described in terms of potentials, forces and energies, and informational systems of the type which occur in biology and the human sciences. Indeed, using the functions $u_{ij}$, I could construct a network, quite analogous to neural networks, whose dynamical structure was precisely that of the rate equations (1).

We can iterate the process leading from (1) to (3). Thus, we can form the quantities

$$u_{ijk}(\vec{x}, \vec{\alpha}, \vec{\beta}(t)) = \partial/\partial x_k(\partial/\partial x_j(dx_i/dt))$$

Intuitively, if such a quantity is positive, it means that an increase in $x_k$ potentiates the effect of $x_j$ on $x_i$; i.e. that $x_k$ is an agonist of $x_j$ in that state. If $u_{ijk}$ is negative, then $x_k$ is an antagonist of $x_j$. And so on.

In the Newtonian paradigm, all these quantities are determined completely by the original rate equations (1). Thus it was of interest to see whether the "informational" structure could give us back a system of rate equations; in particular, could we infer a system of rate equations (1) from the $\{u_{ij}\}$ so that (3) is satisfied?

The way back is clear: form the differential quantities

$$\omega_i = \sum_{j=1}^{n} u_{ij} dx_j .$$

If these differential forms are <u>exact</u>, or <u>integrable</u>, then there must be global functions $f_i$ such that

$$\omega_i = df_i.$$

Put $f_i = dx_i/dt$ and we are done. But the condition of exactness is extremely strong; in fact nongeneric if the state space is of dimension > 2. The familiar necessary conditions for exactness are precisely

$$u_{ijk} = u_{ikj}$$

for all indices i, j, k. But this says that, e.g. the agonism of an activator is identical with the activation of an agonist. In other words, the "informational" interactions of our system are entirely symmetrical, again a most nongeneric condition.

If these conditions are not satisfied, then there is no system of rate equations from which the "informational" structures $\{u_{ij}\}$, $\{u_{ijk}\}$, ... follow. In fact, all these layers become <u>independent</u> of each other, and must be postulated separately. Extending these considerations to the parameters $\vec{\alpha}$ (formal cause) and controls $\vec{\beta}$ (efficient cause), it is not hard to show that in an informational structure of this kind, the causal categories are indeed no longer segregated into independent mathematical elements of structure (and indeed, the nature of the causal categories themselves become much more complicated than Aristotle thought).

It turns out that the class of all these "informational structures" forms a category, as indeed do the Newtonian dynamical or "state-determined" systems. Further, the Newtonian category sits as a very small subcategory in the new, larger one, just as the rational numbers sits as a subset of measure zero in the set of all real numbers. And just as in this latter case, there is a sense in which every element in the larger category can be thought of as the limit of a sequence of elements in the smaller category. In words, this means that what we have called a complex system can be approximated, though only locally and temporarily, by a simple system or mechanism. These facts make clear at once why we have been able to go as far as we have within the Newtonian paradigm, but have been unable to progress further.

The situation thus is quite analogous to those in which the early cartographers, trying to map the surface of a sphere with pieces of planes, found themselves. Locally, and temporarily, their maps were quite accurate, but they became increasingly wronger as larger regions of the sphere were mapped. The only recourse was to keep shifting from one plane to another as the curvature of the sphere became progressively important. In some sense, the sphere is a limit of envelopes of approximating planar pieces, but this involves a global aspect (the topology of the sphere) which cannot be determined by local considerations alone. If we analogize the Newtonian mechanisms with the planar pieces, and a true complex system with the surface of a sphere, we see exactly the same situation. As the complex system changes in time, any simple approximation will get less and less accurate, until it must finally be replaced by another. Depending on our point of view, we will call the growing discrepancy between what the complex system is really doing, and what our simple model predicts it will do, as error, or as emergence.

The consequences of such a radical epistemological shift are profound indeed. For our purpose, it suffices to mention one of them. Namely, since the categories of causation are no longer segregated into independent mathematical structures, and in particular, since there is no longer a "state space" which can be fixed once and for all, there is now room for a category of final causation in the world of (complex) systems. In particular, such a complex system may be equipped with an array of predictive models of itself and its environment, whose predictions can be used to modify or modulate the system's present behavior. Such systems (which I have called quasi-anticipatory, or just simply anticipatory) seem to be ubiquitous in biology at all levels, and of course play an essential role in social systems.

To understand such "model-driven" anticipatory systems, and even more, to understand how they will interact, it is of course necessary to know the models which drive them. From introspection, we know that most of what we call "conflict" arises not so much in an objective situation, but in the fact that widely different predictive models of that situation are harbored by the parties to the conflict.

In any case, it appears that the widening of our class of mathematical images of real, natural systems beyond the class of mechanisms involves some massive epistemological and methodological shifts. However, in return for giving up the concept of the world as mechanism, we obtain many valuable things in return; not least, perhaps, is the capability of dealing with telic, epistemic matters in a perfectly rigorous, scientific, non-mystical way. The admissibility of final cause in dealing with complex systems, which as stated at the outset is a common feature of our perception of both organisms and social systems, may bring closer the establishment of fruitful analogies between the two realms.