SYSTEMS STRUCTURES AND FUNCTIONS

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Structure and Contents

In the past years or so there has been a number of sophisticated articles dealing with everything from the nature of mind to the unity of the sciences, which employ the concepts of structure, function, and sometimes that of system. This paper does not directly address any of these complex issues, it merely reviews the concepts themselves and it represents a limited preliminary attempt to isolate some of the characteristics which serve to distinguish at least some types of structural properties from some types of functional properties.

It seems useful to initially distinguish two domains in which the notion of structure is employed. These will be termed, respectively, conceptual and empirical for want of a better vocabulary. In both these there is a significant similarity in the use of the concept of structure but there are also some interesting differences. Before considering these, however, one other usage of the idea of structure may be identified to provide a basis for comparison and contrast.

Within the realm of pure ideational constructs, for example, uninterpreted mathematics and logical systems, structure may be seen as a form, that is, as some configuration of abstract entities, variables related in some intuitive way or according to a specific rule set which uniquely defines a logical identity. This notion of "structure" is often contrasted with the notion of "content". The structural part of identity is that which features the invariant properties of the identity while the expression "content" refers to those elements which may be replaced, altered, or eliminated without extinguishing the identity under consideration. It is clear that this usage of the concept of structure carries with it part of what is captured by the meaning of both the Aristotelian and phenomenological conceptions of essence. Consider the fact that it is the arrangement of variables which make an argument a modus

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Diálogos, 41 (1983) pp. 73-88.

ponens argument, not its instanstiation, and it is the number of lines and the number of syllables per line which makes a sonnet a sonnet, not that which is assembled by the sonnet, and so forth. As the example of the sonnet suggests, this distinction between variant and invariant carries considerably beyond the domain of pure conceptual construction. Presumably for instance, when Ernst Nagel speaks of the "structure of science" he is talking about those features of science as a human enterprise which are and must remain invariant.[1] Presumably he means as well that any undertaking directed towards providing an explanation about the perceptual world must emulate these explicative features if that enterprise is to receive the honorific label "scientific."

A structure is a unity composed of parts in which those parts are related and inter-related in a fashion beyond or other than that of mere spatio-temporal contiguity. It is doubtful for example, that a heap of stones left by a retreating glacier would be referred to as a "structure." There must be some rule or relationship which makes the presence of one part relevant to the way of being or activity of another part such that the part would exist or behave in a fashion, given the relationship, in a way differently from that where the relationship is not present. Mere spatio-temporal proximity does not necessitate such a modification. Mere aggregations lack structural identity, but beyond this distinction between structured entities, e.g. a virus, and non-structured entities, a pile of bricks, there are other obvious distinctions which can be made among types and levels of structure. For instance, a lower order of primitive structure would be one in which each "part" is related to some other "part," while a higher order unity would be one in which the presence of any given part modifies the way of being of all or most of the other parts and is in turn modified by them. The more intricate the inter-relation the more highly structured a unity may be said to be. In fact, a higher order unity is counted as "higher" because of the number and kinds of interrelationships as well as by that which is connected. Beyond the purely ideational world, the concept of structure is usually coupled not to the idea of content, but to the concept of function.

Here too, it appears to be the case that structural properties may be considered in and of themselves to provide the most fundamental basis for identification; on the other hand, because of its relatively derivative nature, a function, it seems, can only be described relationally, that is, in terms of a structural dependence. Unlike the accidental properties of the Scholastics, which could not exist in themselves and which were

[1] Nagel, Ernest, *The Structure of Science,* New York, Harcourt, 1961.

not necessary to an identity description, functions, sometimes at least, seem to manifest, express, or be extensions of basic structural properties. More than this however, as it will be argued in subsequent sections, the role of functions in some cases anyway, provides the very basis for identification, and is even more central than the definition of the structural correlates.

Functions

While activity is always a component of the concept of a "function" it need not be the component of the concept of a "structure." This feature provides one immediate basis for conceptual differentiation. Including activity, a function predicate involves a minimum of five components:

(1) a structure
(2) an environment
(3) an activity
(4) an environmental terminus (what is done to what)
(5) a structural terminus (what for)

Roles and artifacts provide the clear case of this notion of "function." Some entity x (structure) is used for doing activity y (environmental terminus) in order that z (a structural or systems terminus) be affected. A knife is used to cut bread in order that some persons may better eat the bread so they might survive. Some magistrate (socially designated role) marries some couple in order that they may live in a state of marital bliss without sin.

While the physical properties of an artifact places limits upon the use to which an instrument may be put, they do not uniquely establish that use. A pipe might equally well be used to blow bubbles or more remotely to suck up beer from a peculiarly-shaped container, as well as for smoking tobacco, although it would probably not be very useful for opening a can of soup. The point is, however, that while an examination of the structural properties of a pipe might suggest a range of possible uses, no such examination would determine such use. This is obviously even more the case with a social role. It is only through an examination of the context from which an activity issues and the context within which an activity occurs that the activity may be judged as more than a movement but also a function.

Why this should be so may be discovered in part through an examination of the historical derivation of the notion of function.

The historical context from which the notion of fuction (*functus* = perfomance) is derived, was, by and large, teleological; purposes

were ascribed in the normal course of events to natural objects and processes as well as to persons. This is not now the situation in contemporary biological paradigms. No overall "telos" is ascribed to biological events in general nor are biota held to contain particular principles of organization as provided by some master plan. Some philosophers in fact have come to regard the ascription of functions to non-agents as metaphorical. Whatever the case, and setting aside the special problems surrounding the powers and dispositions of human agency, artifacts and social roles lack one feature which organisms as opposed to organs manifest. All organisms at least sometimes manifest activities which are directed towards the maintenance of organisms per se, while the activities of gunsight mechanisms, thermostats, kidneys, and judges have termini which are in one way or another extrinsic to their respective structures.[2] This is clearly the case with artifacts. Consider the humble paperweight.

Having a certain mass may suit some physical object for use as a paperweight, but having a certain mass also allows the given physical object to interact in a variety of other ways with that which surrounds it. It is only in the instance that the physical properties (mass) of a given object is brought into congruence with a larger pattern of activity involving the previously mentioned components that the property of being a paperweight can be ascribed to it. The physical object is only a paperweight given a context; without such a context it is merely a thing. If this is the case, then analysis of boundary conditions, gravitational laws, and so forth, can provide only a partial distinction of the paperweight function precisely because that function is only a function within a specific web of relationships extrinsic to the object.

A bacteria may be developed which "crunches oil" or a cat may be put in a barn to catch mice. While an analysis of the structural properties of cats and bacteria may provide a description of that which empowers cats to catch mice or bacteria to crunch oil, it will not reveal the congruence of their powers within the purposes and interests of the developers and users of bacteria and cats. It is these purposes which explain the existence of oil crunching bacteria and the presence of cats in barns. The goal oriented behaviours of the respective biota and the conscious purposes of the agent users coincide. In this respect, the cat's requirement for protein and its specific abilities to acquire it, and the inertia property of a rock rendering it suitable as a paperweight,

[2] The terminus needs to be in the structure from which the activity issues as in the instance of a thermostat. A thermostat regulates temperature through a feedback loop but it does not set the desired temperature range, nor is the device as a device, except purely fortuitously, affected by its own activity.

are in principle the same in that each have properties as physical objects which permit the fulfillment of a human purpose.

The ascription of a mouse trap function to a cat or a certain mechanical spring mechanism is allowed by the fact that both will under appropriate circumstances, despite their very different underlying structural configuration, secure and destroy mice, and this power suits the purposes of human agents who can engineer the circumstances rendering liable the destruction of mice. "Being a mousetrap" may be predicated of a cat and of a spring mechanism only in so far as they both share a similar set of interactional properties (the securing and destruction of mice) and the similar intentional framework; that is, both may be placed in a situation in which it is believed mice are present, where mice are undesirable, and where it is supposed that under the appropriate circumstances both are able to secure and destroy mice. It is only within this context that the ascription of "mousetrap" to both makes sense.[3]

Without trying to maintain that there is any strict analogy, organ-functions and artifact-functions display a number of interesting parallels. Artifacts and natural objects which are employed as human instruments are brought into intentional frameworks existing "outside" and beyond any structural or functional property intrinsic to the given object itself. Objects acquire functions. The reasons for an activity, the movement of a chesspiece, a referee's signal, the use of a rock as a paperweight, are to be found in the context within which the activity is performed. Outside of this, a rock is just a rock, a referee's signal just a motion, a chesspiece, a tiny example of statuary, and so forth. Indeed, it would appear to be the case that the more constructed a structural-functional composite is, the less its identity depends upon its object properties, and the more it is defined by the context within which it occurs; so for example, that which exercises political power, a government, may mean an individual plus some advisors, a dictator, an oligarchy, or a parliament, all quite different organizations performing the same general function.

The general meaning of the activity of an organ (at least in its natural

[3] "How are categories derived?" is the question. The suspicion is here, and cultural anthropology seems to provide evidence for the contention, that there are a multiplicity of different ways individuals and cultures construct classes. To approach a category such as mousetrap as a philosopher from an Aristotelian tradition, where class inclusion or class exclusion is decided by a definite set of operations, is to miss the point that in ordinary life what something is may be decided by no more than that it has some instrumental value, and that it is included in a class, e.g. mousetrap, on no more than the basis of a shared instrumental value. A much broader consideration of how categories are generated both historically and culturally is required, as opposed to the special preoccupations underlying the derivation of philosophical and scientific categories.

situation), as is the case with the activity of an artifact, is to be found in its contextual relationship. Explanations of kidney functions, for example, are not found simply by examining the structure of kidneys —that is not just by reductive analysis—but by reconstructing the relations and relational efforts of kidney activity and surrounding organs. The explanatory "movement," then, is compositional[4] to use G.G. Simpson's term.

Functions and Biological Natural Kinds

While the goal-oriented activities of organs and artifacts may be irrelevant to the identity maintenance of the structure from which the activity issues, this is not the case with entities which are members of a natural kind. There the function, at least up to the level of intentional acts, can be shown to have a direct bearing on the survival of both the individual and the species.

This appears true in two very different senses. The activities which are predictable of an organism usually are not directly goal-oriented in terms of some other structure or system, but rather are oriented towards the maintenance of the configuration as such.

The ingestion of a mouse by a snake is not solely directed towards the snake's liver or brains or whatever, but, since every cell, organ, etc. requires energy, is directed towards each and every animate portion of the snake. The evasive action of a rabbit under attack by some predator is directed towards maintaining the integrity of the rabbit as a whole, not any given part as such.

While an organism survives through what it does, different organisms have typically different ways of promoting their existence. The dispositions which empower alternative adaptive mechanisms are not accessible to observation, so it is the observable morphological traits, together with characteristic behaviours, which provide the possibility of categorization. Even, however, if it were possible to isolate the morphological and genetic basis of any species-related activity, the full biological meaning of that activity would not be had. The intelligibility of the activity, if the notion of evolution is accepted, can only be uncovered through a description of the history of the development of a given species as well as in the myriad ecological relationships which condition any living organism's situation. So biological descriptions, if they are to be adequate, as with artifacts and organs, require contextual reconstruction. Unlike, however, the description of organs, and artifacts,

[4] Simpson, G.G. *This View of Life*, New York: Harcourt, 1964.

there is a level of explanation beyond that of observable physical attributes, and "before" that of contexts, which relates dispositions and activities to identity persistence.

If what is being argued is correct, and it is the case that identity of artifacts is established mainly on the basis of functional properties, it would appear also to be the case that the identity of a natural kind is discovered in part through its functions, and that while structural predicates appear to be identity criteria as such, functional properties are always relational and derivative. If this is the case, then an organic entity, like an organ, or an artifact can never be fully described in and of itself but only in terms of its manifested goal orientation and its history, as well as whatever underlies and empowers this orientation.

Function Levels and Social Constructs

Perhaps there has been a conflation of not two but three ontological levels which has added to the difficulty of identifying and distinguishing structural and functional properties. This first order would involve artifacts, the second, organs and organisms, and the third, social constructs, i.e. institutions, social roles—if it is accepted that social constructs are generated by real or perceived social needs.

There are, as cultural anthropology attests, a multiplicity of ways in which various activities have evolved structures to meet similar needs. Supposing, for example, it is true that all social groups must create the same means to stabilize interpersonal expectations so that the joint and cooperative activity necessary to the maintenance of any group may be affected, and supposing also that the creation of rule frameworks has led to one universally adopted means to achieve this end, then the identification of a given function, considered in cross cultural way, is to be achieved through the identification of this need and the specific rule guided performance undertaken to meet the need. It appears, to take another example, that every society requires instruments which prohibit or elicit behaviour. If the instrument involves a rule framework, then no matter what the basis of the authority or the organization that is ruled by one, by some, or by many, which constitutes its structure, the label "judicial function" may be applied on the basis of the identification of the sameness of need and the general similarity of procedures for achieving the desired results.

In a sense, in the realm of social constructs at least, it appears to be true that form does follow function. Some x is required. Some u, v, w, (rules, procedures, practices) are adopted to achieve x; some A, person(s) are empowered to create, oversee, or amend, $u\ v\ w$. Sense can only be made of A on the basis of the identification of $u\ v\ w$ and x. A acquires

whatever status or identity that it has because it furnishes, along with other possibilities, a means for the operational achievement of *x*.

In a certain sense this is nearly the converse of the situation as it concerns physical systems which have no functional correlates. Using the oft-cited example of temperature, it can be seen that according to the usual definition, temperature is the mean kinetic energy of the molecules of some physico-chemical system. The causal foundation for the phenomenal experience of temperature is identified with the number, velocity, and interaction of molecules. The basic explanatory motion is reductive. A macro-phenomenon is explained by, that is, given "deeper" meaning, as the composite result of its more basic constituent elements. While the consequent phenomenal temperature is understood through and explained by analysis of its structural antecedents, the structural component of an institution acquires its meaning and is understood by the identification of its goal direction.

The situation with artifacts appears to be similar in many respects to that of a social role. It appears to be the case that just as a social role is primarily defined by the end towards which its performance is directed, an artifact is defined primarily by the use to which it is put. One immediate difference of course, between the two orders, is that the structure of a social role, while it may have physical components, exists primarily as a conceptual set, while physical objects, artifacts, exist on their own account, whatever their use. On the basis of this, Frederick Adams,[5] for one, has suggested that there may be an identity between function and structural predicates, so that just as a physicist explains temperature as the motion of molecules, so phenomena associated with the output pipe may be identified with those causal properties which mediate the stage between "output" and "input" via its structure. Hence,

(a) Function	(b) Structure
1) Holds a quantity of tobacco	Has a high kindle-temperature
2) Tobacco does not readily burn	Has a high kindle-temperature
3) Transports smoke to one's mouth	Has a mouth-piece
4) Allows air-flow for oxidation	Is irregular hollow cylinder.[6]

It is interesting to note in passing that as an explanatory paradigm Adams employs a systems description, and as it will be argued in a

[5] Adams, Frederick. "Properties, Functionalism and the Identity Theory"; in *Eidos* Volume I, Number II, December, 1979.

[6] Adams, Ibid., p. 168.

subsequent section, system explanations map a territory where the focus of interest is different from an alternative to that of a structural-functional map.

While 1, 2, 3, and 4 of the causal properties of being a pipe may be correlated with a variety of other possible uses to which the object under description may be put, 2 is strictly relevant to the specific activity that is "smoking a pipe." Its relevance, however, only becomes apparent given a prior undertstanding of how a pipe is in fact used; without this understanding there is no way to decide whether or not the higher kindle feature is accidental or essential, that is whether it is merely a feature of the object as object, and as such has no significant role in a causal mediation, or, on the contrary, is directly germane to it.

While it is appropriate to speak of use relative to artifacts and performance relative to social roles, it is evident that speaking of use in relation to organs involves a metaphorical extension. Strictly speaking, kidneys and lungs are not used by anything, although they do perform certain functions in various living contexts. Yet kidneys and lungs, just as artifacts and social roles, are prefigured to and directed towards ends extrinsic to their structure as such. The brain is not used to process information, it just does so, yet brain functions allow or enable a range of behaviours as if designed to do so. Instead of specifying organic function on the basis of use, with the attendant connotations of intention, it would perhaps be more suitable to specify organic functions according to that towards which the organic structure is adapted. This, of course, still requires the notion of activity with a terminus extrinsic to a given structure as a necessary specifying feature of a functional predicate. From this perspective, the description of the function of organs is not different than any other types of functional description.

Systems

Closely allied to the notion of structure is the notion of system. The idea of system, however,[7] particularly as it concerns those systems which have determinable input, throughput, and output features, has a somewhat vague and shifting usage.

There is a clear difference, however, between speaking of a virus as a system and the structure of a virus. The first refers to a specific way in which certain parts are organized to form a whole, while the second, that of structure, here approaches the notion of form, where a virus

[7] There are multiple senses of "system," prescriptive and descriptive, which are other than that employed here, e.g. solar system. The usage throughout this paper is restricted to only those systems which display input and output.

is understood to exist as one sort of microscopic entity and it is known that there are other sorts of microscopic organisms whose manner of organization is substantially different. An explanatory schema which considers the virus as a system brings together part of the conception of structure[8] and part of the idea of function, that is, a system is an organized whole which does something. A system is an organization existing (1) in a milieu, (2) extracting or deriving something from that milieu, which is (3) processed or transformed according to the way the system is organized, and where there is a (4) consequent something returned to the milieu. The concept of structure need not contain any reference to (1) and (2); nor does (4) as outputs are characterized in many systems descriptions, make reference to that towards which a systems output is directed. There seems to be another aspect of the idea of system, particularly as biologists use it, which further separates the concept from the notion of structure.

Systems may be seen as a kind of arrangement of structures and functions as in "nervous" systems or reticular activating systems or hormone systems. In this sense a system is not more than a particular linkage of entities. It is, unlike the case of a cell, heart, or lung, incapable of any independent or quasi independent existence outside the milieu in which it appears. This is presumably because a system lacks the complexity of integrated arrangement which are requirements for independent existence and structure identification. In so far, however, as a virus and its functioning may be considered a system this clearly does not apply, so that perhaps the classificatory preoccupation which underlies the accidental-essential categorizations does not figure as a consideration in systems descriptions at all.

Yet it would seem that something like these preoccupations does reenter theoretical considerations in the context of certain problems. How this is so may be seen by a closer look at the idea of a system.

(1) A system is said by Kramer and Smit to be a "set of interrelated entities of which no subset is unrelated to any other subset."[9]

(2) "A system as a whole displays properties which none of its parts or subsets has: and every entity in a system is either directly of indirectly related to every other entity in it."[10]

Speaking negatively, this concept of system would appear not to carry with it, at least explicitly, the connotation that some use of "structure" does; that is, of properties interrelated in a type-identical fashion, as the properties associated with animality, together with the specifically defining difference, rationality, are said to provide the "essence" of the species Man. The notion of system however, does focus on other aspects of identities, which is not to be found within the concept of structure.

The definition provided by Kramer and Smit misses the most interesting feature of systems description. The identity of a system, that is its specific configuration, is only of interest in so far as it provides the basis of the transformation of some x into some y in some characteristic fashion. It is the relationship of input to output that is of main concern in this kind of description, the causal mediation, not the identity features per se. Identity features only enter into a systems account in so far as they are seen to be relevant to a specific transformation. According to the scholastic dictum, *Operatio sequitur esse* (behaviour follows "nature"), systems analysis attempts to identify what sort of relational conditions allows or create some throughput and some output deemed to be desirable or organically useful. In so far as the manner of organization is relevant to the consequent behaviour, the structure analyst and the systems analyst have a point of contact. However, in the attempt to work out the causally mediating factors, the systems analyst demonstrates an interest and employs a vocabulary which is different from that of the structural analyst who is, it is to be supposed, fundamentally concerned to establish whatever properties are necessary to an entity in order that it be that entity and not some other.

For example, a system-relation is said to exist, by such analysts as Kramer and Smit, if a change in a property of one entity results in a change in a property of another entity. What is termed a "relation" involves the description of the dependency of one entity on another in respect to a given manner of being. A system-relation may be said to be present when the alteration of a given property of an entity results in an alteration of the entity itself. The addition or subtraction, for

[8] Again Adams for one does not sufficiently distinguish the two concepts, in fact he regards functions in the context of systems description. He says "...the essential feature of a functional relation is that of a means-ends relation. For a structure x to have a function y is essentially for x to do y in a system s and for y to lead to the fact that the system is able to output a value o. The output value o will either be a goal state s or causally contribute to s's attaining a goal state." Adams, F.K. "A Goal State Theory of Function Attributions" in *Canadian Journal of Philosophy*, Vol. 14, No. 3, September 1979, p. 493. Firstly the idea of system appears to be too narrow. Does, for example, a legal system appear within a cultural "system"; the term "context" seems preferable. Secondly, "system" may be used as a synonym for "structure" in some cases. Thirdly, the term "structure" has, if the argument previously given is correct, an identity meaning which the term "system" does not. Finally systems descriptions presuppose but need not make reference to goals or ends as such.

[9] Kramer, J.I. and Smit, *Systems Thinking*. Leiden: Nijhoff, 1977.

[10] Ibid.

example, of a point to or from a given geometrical figure does not alter the relations of any given point to any other point in the pre-existing figure. Such an alteration does, however, alter the definition of the figure as a whole.

Dynamic systems may display alterations in configurations which occur within definable limits. These limits provide the possibility of typing a system as a given system. Within these limits various characteristic alterations may occur and these are referred to as states. The expression "state" refers to some configuration of entities and relationships at a given moment of time.

A state may be related to another state as a "higher" order relationship just as an entity may be related to another entity. Where one state gives way or is superseded by another, the resulting pattern is known as a "process."

Two examples of concrete systems might help to explicate the several different facts of the structure-system description. A radio receiver as a system is composed of inter-related entities which perform, in at least in the simplest sets, the following functions:

a) A device for the reception of electro-magnetic waves in the frequency range from approximately 10 kilocycles/second to 300,000 megacycles/second; that is, an antenna.
b) A device which selects a specific frequency (preferred) from the previously mentioned range.
c) A device which functions to allow electron pulses to travel in one direction from aerial to ground but which will not allow the reverse flow. This device, for example, by acting as a gate causes the electron surges to be re-routed through another subsystem.
d) A device (earphones) which transforms the relatively high frequency electron surges to lower frequency surges, less than 20,000 cycles per second, placing these within the audio range.
e) There are of course the wires which physically relate the various components. Any alteration in the sequence of relationships will destroy the general function of a radio receiver. Further, the malfunction of any of the parts will produce, in all probability, either a deterioration or cessation of that general function.

An alteration in the quality of relationships which persists through some period of time will result in a change of state. With, for instance, the generation of radio receivers following the simple crystal sets, a form of amplification was achieved by using a feed back loop to increase the power input to the set so that the weak signals from the antennae

were reinforced. This socalled regenerative type receiver functioned most efficiently just prior to going into oscillation, that is, just to the set acting as a transmitter by generating its own frequency waves. After the point of oscillation was reached (by, for instance, increasing the voltage), the receiver was said to be in a state of oscillation. This undesirable state could be replaced by increasing the resistance in the total circuit and thus altering the electrical relationship among the various components, so that the desired state of radio frequency amplification could be achieved.

Systems, Functions and Forms

For a creature with no ears but with a knowledge of electronics, it might be possible to discover that radio receivers transform electromagnetic waves into disturbances occurring in a gaseous medium, but such a creature could not know whether that was a desirable state. Its discovery and its subsequent descriptions would lack explanatory power because what a radio system is, is only fully explicable in terms of what a radio does in the sense of what purpose it fulfills. Whatever the material organization, whether crystal diode, vacuum tube, or solid state, various types of material organization create the relatively stable dispositions or powers for extra-systematic activity which allows the fulfillment of some purpose. It is this purpose which creates the disposition and the evaluative criteria and not the other way around.

A systems description presupposes a content in which there is purpose, goal orientation, or at the very minimum, some organization in which alterations occur within definable limits. Typically, the focus of a systems description is either on how the organization of the system creates the conditions for some activity issuing from the system or how some modification in a given system or complete alternative to it might achieve a similar effect, one which for some reason or another is considered desirable.

An intelligent entity lacking auditory sensation could conceivably make out how each subcomponent of a radio system acts and correctly decide what the final output is, but without some access to information about the way in which human beings process auditory stimuli, it is difficult to see how any decision could be made as to what a radio system is, that it is a device which allows communication over relatively large distances. Again, it would seem to be the case that without information about the wider content such an entity would never be in a position to decide either function or malfunction. A radio issuing a series of squeals would appear basically the same as that of one issuing a sonata.

Systems description then presupposes a background of function

recognition which need not and does not usually enter into a systems account, yet this background is required for successful systems description or structure.

If this is correct, a pipe, for instance, may be considered from a systems perspective without reference to its function; that is, in terms of the temperature quality and so forth. However, these properties only have significance given a prior understanding of its use. A pipe is a pipe not directly because of its object properties but because these object properties lend themselves to a specific employment.

The production of a desired effect in the most efficient way entails the examination of configurational properties, and this is one of the major concerns of systems analysis. Nevertheless, questions of efficiency appear to be here as elsewhere derivative, dependent in the case of artifacts upon human intentions, needs, powers, and programming and environmental contigencies.

It appears to be the case in those instances involving human construction that a large variety of possible materials, rule frameworks and so forth, may be employed in the fulfillment of some end, so that the analysis of any given physical stuff is not sufficient to explain in an essentialistic way a specific range of functional activities. And yet it would seem there are certain invariants, at least in the case of some physical systems, which must be present if certain activities are to occur.

In a certain context, at least, a switch in focus from the physical properties and relationships of a system as such to the socalled logical properties as such marks a shift from the utilitarian preoccupations of the systems engineer to the definitional and intelligibility concern of the philosopher. It is interesting to notice that the discussion of logical properties or Turing functions issued from theoretical considerations of so-called artifical intelligence; that is, as an outgrowth of questions concerning the nature of thought, mind, consciousness and so forth, questions concerning conceptual substantiation and clarification, questions whose successful resolution are necessary to a correct interpretation of empirically derived data. One result of this inquiry would appear to indicate a curious feature about the part of the world at least which is the product of human construction. It would seem that, to a degree at least, independently of the matter involved, parallel behaviour may issue from very different stuff. It appears that different sorts of materials may be made to function in similar ways and that series of functions in specific arrangements can create a like disposition for behaviour.

It might be correctly argued that this is not the case, that for example, a radio system, whether vacuum, transistor or solid state, involves an

identity of stuff at least relative to input, throughput, and output. However there are other systems in which even this level of physical identity would appear not to be important.[11]

A clock, for example, is a device whose motion is synchronized or correlated with another system in motion. The cyclic motion of the sun is paralleled by the cyclic movement of the hands of the clock, and by this analog the motion of the sun is divided into regular and additive intervals.

Most clocks, whatever their construction, must have a source of motion, some periodic movement, and a movement counter. The first might be achieved by a spring, a weight, or a radio signal discharging into a container of hydrogen; the second by a pendulum, a "grass hopper" armature and a set of gears, or by the atomic oscillation occuring in the before mentioned container, the third by the familiar hands on the face of a wind-up watch or by a small coil which picks the energy released by atomic oscillation and communicates the pole to an electronic device which counts, adds and displays the pulses.

It is clear that only some types of system could be used for such synchronization. Periodic movement of some sort is a necesary condition for being a clock. However, as the example illustrates, a tremendous range of systems do or can be constructed so as to feature this sort of activity. Even given this feature, however, a system does not become a clock. The synchronization, the use to which a clock is put, is defined in a context extrinsic to the physical system itself. Knowledge of use establishes and defines the fact of being a clock and this is what gives or makes periodic activity the essential feature of a given system relative to this use. Without a knowledge of the larger context no predication could be made about function no matter how exhaustive the analysis, and without this knowledge no synonymy could be established between such physically divergent systems as Goddard Maser clocks and the familiar wrist watch, because there would be no way of establishing which of the myriad characteristics of each should be placed in parallel.

At the bottom, then, the term "logical property" would appear to refer to a constituent interaction, or series of subfunctions, considered in arrangements which allow or condition some given goal orientation.

The case with natural kinds is more difficult. If, however, evolutionary theory is supposed in some form or another to be true, the rule and

[11] In so far as events occur in a law-like universe there appears to be something like a practical necessity which sets a limit to the number of ways that anything might be done. Nevertheless, there exists the possibility that not only does there not need to be a uniquely defining stuff, there need not be a uniquely defining set of necessary logical properties.

intention frameworks providing the definitions for artifacts may be placed in parallel with environmental stimuli, genetic regularities, and organic adaptive tendencies. If this is true then defining differences are to be accounted for by environmental factors acting upon self-regulating and selfreplicating systems.[12]

Beyond empirical considerations, there remains the conceptual question of what constitutes good and adequate explanation. The question remains "After the identification of 'what?' is the reductive causal 'how?' sufficient to the explanation of all dimensions of the world?"[13]

What has been argued here concerning the concepts of structure, function, and system attempts to indicate that the reductive causal "how" is indeed not globally adequate.

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[12] It is interesting to notice, and there is supporting evidence, that evolution may create similar capacities from quite different organic configurations.

[13] Simpson's arguments for the necessity of alternative types of explanation in biology is to be found in *This View of Life, op. cit.*, as well as other places.