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BASIC CONSTRUCTS OF SYSTEMS PHILOSOPHY

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In a recent paper this writer argued for the importance and feasibility of a synthetic kind of philosophy based on an integration of the current findings of the empirical sciences.[1] Termed Systems Philosophy, the suggested attempt at constructing a general philosophical theory which could eventually function as a new paradigm of contemporary thought has been outlined in greater detail in a book,[2] and shows many traits of 'family resemblance' to systematics. Hence a brief outline of some of its basic constructs may be of interest here.

Systems philosophy, like systematics, is predicated on the assumption that thinking in terms of systems about man and the world is not to force the facts of experience into the Procrustean bed of a preconceived abstract scheme, but is warranted by the currently much discussed applicability of systems concepts to many spheres of inquiry. We perceive and understand in systems terms because phenomena are perceivable and constructable as systems. (Whether they *are* systems independently of our knowledge of them is a moot question, to be answered only by a God.) The ways we perceive and conceive of phenomena can be integrated in a general conceptual framework called Systems Philosophy. Its closest analogue within systematics is Pure Systematics, "which seeks to identify and describe the universal properties or attributes common to all systems."[3] Of course, systems philosophy has practical applications, as well as areas of formal specification, and thus crosses the divide between formalism/empirical theory/practice together with systematics. At this time I should like to concentrate on the pure or theoretical aspect of systems philosophy, and suggest some constructs which are basic in the formulation of a general theory of systems. These constructs can then be used as the premises of a general philosophical theory having the required properties of synthesis and empirical relevance.

All theory construction of the empirical world presupposes that the world beyond human knowledge and experience is in some respects rationally ordered. There can lie no theory of a chaotic universe, and inasmuch as we do have theories of the universe we hold them on the expectation that the universe is not—or not entirely—chaotic. Once this assumption is made, we confront the dilemma of special methods and special constructs to deal with particular phenomena with optimum fidelity, or using some general conceptual tools and frameworks to attempt to understand the interconnection of diverse phenomena. The specialist is motivated by a desire to achieve optimum adequacy to the phenomena in his constructs, and builds models and proposes theories with an eye solely on the accuracy of the match with nature. The generalist believes, on the other hand, that one does not adequately understand any phenomenon unless one knows its interconnections with other phenomena, and he seeks to produce those general concepts and frameworks which could prove to be adequate for the understanding not only of isolated events, but of general patterns of relationships. The methodological supposition of the specialist would be superior to that of the 'generalist' if phenomena would indeed lend themselves to accurate mapping only through specific laws and concepts. But phenomena do not impose their own categories with finality, and a number of different (and according to Kuhn and Feyerabend,[4] even incommensurable) theories can be confirmed in regard to any set of phenomena. The selection between theories depends in the last analysis on the preferences of the investigators. These preferences are not 'merely' psychological quirks, however, but underlie all rational modes of thoughts. They are the values of thinking with empirical accuracy and yet with heuristic power conferred by economy, internal consistency, and wide range of applicability. Theories which combine empirical ideals of accuracy with the rational ideals of economy, consistency and generality have the edge over theories that sacrifice one component for the sake of others. Those that sacrifice the rational factors become *ad hoc* and their scientific status is corresponding lower (as Popper, among others, clearly noted[5]). Others, which sacrifice empirical accuracy for the rational component's elegance and heuristic, strain credulity and belong to the realm of rationalist theology and metaphysics. Somewhere between these extremes lies the ideal of a scientific theory, where empirical and rational ideals are optimally combined. It is my belief that systems philosophy, as systematics, belongs to this range.

The foundation of systems philosophy is the recurrent applicability of empirically precise systems concepts in diverse fields of investigation. Cybernetics, general systems theory, information and game theories, and an entire constellation of mathematical and empirical disciplines emerged with striking rapidity since the 1950s. They are not unprecedented in contemporary or even classical thought of course ("organistic” thinking was characteristic already of Greek cosmologies and reappeared in the modern age in the works of Lloyd Morgan, Henri Bergson, Alfred North Whitehead, Samuel Alexander and John Dewey—to mention only the key proponents), but the empirical accuracy which this mode of thought could now achieve is unparallelled by earlier attempts. The insights of past generations of thinkers may have been as great or greater than those of systems thinkers at present, but they lacked the empirical base which is now applied by the natural and social sciences. These sciences give us not only mere sophisticated theories, but qualitatively different ones: they are, on the whole, no longer atomistic, mechanistic and reductionist, but tend toward the appreciation of wider contexts, general theories, and irreducibilities. Classical concepts and methods still hold their own in contemporary science, but the spotlight is increasingly taken by the sciences which supplant them with systems concepts. We need only to consider such recent and still rapidly rising ‘stars’ as ecology and world-system modelling, to appreciate this trend.

Systems philosophy is envisaged as a general philosophy of man and nature, using the invariant constructs which recur in isomorphic transformations in the various systems-oriented sciences. The scientific theories are used as anchor points for constructing an embracing philosophy which is no less empirically relevant than the systems models upon which it is built, but is considerably more general in scope. Hence it responds to the rational ideal of contemporary science without losing sight of its empirical ideal.

Empirical sciences map phenomena from their own particular disciplinary perspective. For example, man, perhaps the most complex of all phenomena, is mapped from the perspectives of biology, psychology, the social sciences, and diverse philosophies, e.g. existentialism, idealism, spiritualism, etc. Each strand of order elucidated by inquiries from these different perspectives tells us something about man. But none does him justice, for man is a biological, as well as a psychosocial entity. In an integrated systems philosophy he can be recognized as such, by taking the isomorphies appearing in the different perspectives as starting point, and finding the invariance which underlies them. That invariance is man himself.

When we look for invariant orders (Bohm suggests that all rational inquiry does that[6]), we simplify and organize the rich stream of phenomena. If this process permits us to recover the wealth of empirical diversity by derivation from our model, its simplification and organization confers meaning without essential distortion. If systems concepts do indeed apply to a wide realm of empirical phenomena, the invariances which they code are empirically adequate through detailed application. For example, although the concept of negative feedback control is a simplification and organization of a wide variety of data, it permits one to comprehend the principle of operation in phenomena as diverse as the ordinary room thermostat, the sonar-guided underwater torpedo, the instrument landing system of modern airplanes, and the homeostasis of the human body. There is no mechanistic—or even essentialistic or spiritualistic—explanation which would have comparable integrative power without loss of empirical accuracy.

The methodological principles of systems philosophy are represented in the following graph, where the overarching unity of nature within its manifest diversity is heuristically assumed, and the capacity of particular empirical systems sciences to grasp such orders under specific aspects accounted for.

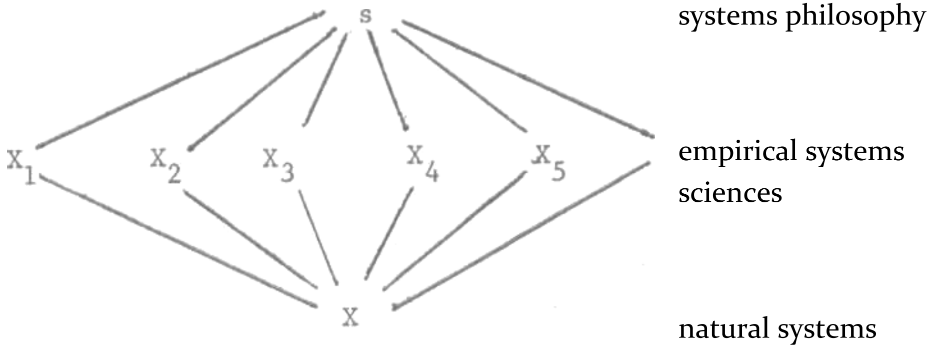

Fig. 1.

I shall now suggest four basic constructs of systems philosophy. These I found to be extremely fertile, in enabling investigators to construct a general model of systems, which finds detailed empirical application in empirical fields as diverse as physics, biology, psychology, and the social sciences. In this paper the application of the constructs to these fields cannot be demonstrated, but the reader is referred to the work already mentioned.[7]

The four constructs jointly define the general system's attributes. The set of general systems we are dealing with are those called 'natural systems', i.e. systems which arise independently of conscious human planning and execution. (Since almost all social and cultural systems arise in this way, they, too, are included in this definition. The primary set of excluded systems arc the *artificial* systems.)

Let the general class of natural systems be defined by the symbol R. Each of the four properties is given a symbol $\alpha, \beta, \gamma, \delta$. Then any natural system can be defined by one particular combination of transforms of the basic equation,

$$R = f(\alpha, \beta, \gamma, \delta)$$

An identification and brief discussion of each of the constructs follows.

ORDERED WHOLENESS— α

An ordered whole is a non-summative system in which a number of constant constraints are imposed by fixed forces, yielding conditions with enduring mathematically calculable parameters. A system of this kind always contains an element of order; complete randomness is excluded from it.

Wholeness defines the character of the system as such, in contrast to the character of its parts in isolation. A whole possesses characteristics which are not possessed by its partly singly. Insofar as this is the case, the whole is other than the simple sum of its parts. (For example, an atom is other than the sum of the component particles taken individually and added together; a nation is other than the sum of individual beings composing it, etc.). However, no mysticism is implied or involved in this assertion. Traditionally, wholes were often considered to be qualitative and intrinsically unmeasurable entities because they were seen as "more than the sum of their parts". This conception is spurious. Wholes can be mathematically shown to be other than the simple sum of the properties and functions of their parts. Consider merely the following basic ideas. Complexes of parts can be calculated in three distinct ways:

(i) by counting the *number* of parts,

(ii) by taking into account the *species* to which the parts belong, and

(iii) by considering the *relations* between the parts.[8]

In cases (i) and (ii) the complex may be understood as the sum of the parts considered in isolation. In these cases the complex has *cumulative* characteristics: it is sufficient to sum the properties of the parts to obtain the properties of the whole. Such wholes are better known as 'heaps' or 'aggregates', since the fact that the parts are joined in them makes no difference to their functions—i.e. the interrelations of the parts do not qualify their joint behavior. A heap of bricks is an example of this. But consider anything from an atom to an organism or a society: the particular relations of the parts bring forth properties which are not present (or are meaningless in reference to) the parts. Examples of this range from the Pauli exclusion principle (which does not say anything about individual electrons), through homeostatic self-regulation (which is meaningless in reference to individual cells or organs), all the way to distributive justice (likewise meaningless in regard to individual members of a society). Each of these complexes is not a mere heap, but a whole which is *other* than the sum of its parts.[9] Mathematical examples for both summative and constitutive complexes can be readily found.[10]

The mathematics of non-summative complexes applies to systems of the widest variety, including physical, biological, social and psychological systems. These systems form ordered wholes in which the law-bound regularities exhibited by interdependent elements determine the functional behavior of the totality. The fallacy of reducing a whole atom to the sum of the properties of its parts is well known to atomic physicists; the analogous fallacy of reducing the whole organism to biochemical reactions and physical properties manifested by particular components is becoming increasingly recognized too (Hans Selye's latest book is subtitled "The Case for Supramolecular Biology"* - * Hans Delye,. *In Vivo,* New York Liveright. 1967.), and social scientists, as well as social and individual psychologists accumulate evidence every day concerning the unfeasibility of explaining either social or psychological events by reference to the qualities of the individual components, e.g. the motivations, wishes and habits of individuals, and the properties of particular cognitive or emotive factors. One need not embrace a metaphysical holism and radical emergentism to subscribe to the proposition that the concept of an ordered whole which is other than the sum of its parts is not a mystical and unverifiable concept but one which is generally used in the natural, psychological and social sciences today.[11]

SELF-STABILIZATION— β

A whole is an entity that forms a dynamic balance between internal fixed constraints, which impose its enduring structure, and external unrestrained forces, which mould the structure and evolve the entity. The presence of fixed forces brings about a steady, or stationary, state when all flows induced by unrestrained forces vanish. When unrestrained forces are introduced into a dynamically balanced system disposing over fixed constraints, the system will tend to buffer out forces which perturb its stable configuration. As Katchalsky and Curran have shown, any fluctuation in such a system gives rise to forces which tend to bring it back to its stable configuration due to the fact that the flow caused by the perturbation has the same sign as the perturbation itself. Hence the flow will reduce the perturbation and the system will eventually return to its steady state. If the perturbations vanish, the system is characterized by the parameters of its fixed constraints. If both the fixed and the unrestrained forces vanish, the system reaches a state of thermodynamic equilibrium[13] (it becomes a heap, rather than a dynamically ordered whole).

In the stationary state the systems are the most economical from the energetic viewpoint since they lose the minimum amount of free energy. (A still more economical state is the state of thermodynamic equilibrium; in that state, however, the systems are no longer ordered wholes.) Minimum entropy production characterizes the complex systems we term ‘living’, which slow down the process of thermodynamic decay during their lifetime and remain in stationary states characterized by the typical constraints making up the species-specific organization of the individual. As Katchalsky and Curran point out, living systems are endowed with a series of regulating mechanisms that preserve the steady state and bring the organism back to its unperturbed condition in a way which resembles the action of a restoring force coming into play in any fluctuation from a stationary state in a physical system.[14] Inasmuch as both physical and biological systems maintain themselves in stationary states, characterized by the parameters of the fixed forces within the systems, life as a cybernetic process is analogous to any physical system describable, by our definition, as an ordered whole. But we must recognize that in a biological system the stationary states are not fully time independent: they are *quasi*-stationary.

The here discussed general system property abstracts from the many varieties of regulatory mechanisms and generalizes the concept of adaptation to the environment through the self-maintenance of systems forming ordered wholes. The generalized conclusion may be stated thus: within a limited range or perturbation, an ordered whole will tend to return to the stationary states characterized by the parameters of its constant constraints. Inasmuch as the systems reorganize their flows to buffer out or eliminate the externally introduced perturbations, they *adapt* to their environments. This is adaptation in a limited sense—a more striking form of it, involving the reorganization of the fixed forces themselves, will be discussed next.

SELF-ORGANIZATION—γ

We have shown that ordered wholes, i.e. systems with calculable fixed forces, tend to return to stationary states following perturbations introduced from their surroundings. It is likewise possible to show that such systems *reorganize* their fixed forces and acquire new parameters in their stationary states when subjected to *constant* perturbation (the action of a physical constant) in their environment.

This conclusion follows if we consider Ashby's principle of self organization with some modifications. The latter concern the substitution of 'ordered stationary state' for Ashby's 'equilibrium state' in reference to *natural* systems. Undertaking the pertinent substitutions, Ashby's principle of self-organization reads as follows.

We start with the fact that natural systems in general go to ordered stationary states. Now most of a natural system's states are non- stationary. So in going from any state to one of the stationary ones, the system is going from a larger number of states to a smaller. In this way it is performing a selection, in the purely objective sense that it rejects some states, by leaving them, and retains some other state by sticking to it. Thus, as every determinate natural system goes to its stationary state, so does it select.[15]

The selection described by Ashby involves not merely the reestablishment of the parameters defining a previous stationary state of the system after perturbation, but the progressive development of new stationary states which are *more resistant* to the perturbation than the former ones.

Ashby suggests the following example. Suppose the stores of a computer are filled with the digits 0 - 9. Suppose its dynamic law is that the digits are continuously being multiplied in pairs and the right-hand digit of the product is going to replace the first digit taken. Since even x even gives even, odd x odd gives odd and even x odd gives even, the system will “selectively evolve” toward the evens. But since among the evens the zeros are uniquely resistant to change, the system will approach an all-zero state as a function of the number of operations performed.

Ashby concludes that this is an example of self-organization of the utmost generality. There is a well-defined operator (the multiplication and replacement law) which drives the system toward a specific stationary state (Ashby’s ‘equilibrium state’). It selectively evolves the system to maximum resistance to change. Consequently all that is necessary for producing self-organization is that the ‘machine with input’ (the computer—dynamic-law system) should be isolated. Adaptive self-organization inevitably leads toward the known biological and psychological systems. *“In any isolated system, life and intelligence inevitably develop”* (italics in original).[1,1] Or, to quote his more general conclusion, *“every isolated determinate system obeying unchanging laws will develop 'organisms' that are adapted to their ‘environments’ ”* (italics likewise in original).[17]

The above argument applies to the present thesis with the suggested two modifications: (a) it is restricted to natural (as opposed to artificial) systems, and (b) the operator drives not toward u state of equilibrium in the system, but toward stationary or quasi-stationary *non-equilibrium* states. The reasons are potent for discarding the concept of the equilibrium state in favour of that of a non-equilibrium stationary state in *natural* systems: (i) equilibrium states do not dispose over usable energy whereas natural systems of the widest variety do; (ii) equilibrium states are ‘memoryless’, whereas natural systems behave in large part in function of their past histories. In short, an equilibrium system is a dead system—more ‘dead’ even than atoms and molecules. Thus, although a machine may go to equilibrium as its preferred state, natural systems go to increasingly organized non-equilibrium states.[18]

The modified Ashby principle shows that in any sufficiently isolated system-environment context, the system organizes itself in function of maximal resistance to change in the environment. Its new level of organization is measurable both as negative entropy, and as the number of 'bits' necessary to build the system from its components. Every system produces entropy relative to time. Disorder in systems grows at a rate ds/dt. This is the dissipation function, ψ . T may be positive, negative, or zero. If ψ is zero, the system is in a stationary state. If ψ is positive, the system is in a state of progressive disorganization. But if is negative, the system is in a state of progressive *organization,* that is, it actually decreases its entropy or, what is the same thing, gathers information $\psi < 0 = d\ \text{info}/dt > 0$.

The positive, negative or zero entropy change is governed by the relative values of the terms in the Prigogine equation: $dS = dS_e + dS_i$, where dS, denotes entropy change through the input and dS_e entropy change due to irreversible processes within the system. Whereas dS_e is always positive, dS_i may be positive as well as negative. If the latter, the system 'imports negentropy' (Schrodinger) and cannot only offset disorganization by work performed within its boundaries, but can actually use the excess free energy to organize itself. Thus there is nothing mysterious or *sui generis* about self-organization to states of higher negative entropy: it is a physical property of systems, regardless of their materials or origin.

Self-organization conduces systems toward more negetropic states; self-stabilization maintains them in their pre-existing state of organization. In an environment in which constant forces are operative, and the perturbations they occasion are within the range of correction by selfstabilization, systems not only survive, but evolve. The development of systems in such environments can be conceptualized as a sequence of parallel, or irregularly alternating, stabilization around the parameters of existing fixed forces and re-organization of the fixed forces in function of increasing resistance to the constant forces in the environment.

HIERARCHIZATION—δ

Self-stabilizing and self-organizing ordered wholes (systems constructs /3. 7, *a)* sharing a common environment impose systemic order on that environment. Sets of mutually interacting systems form supra- systems and organize themselves as parts within the emerging whole. The thus formed system can interact with other systems on its own level, and form still higher level suprasystems. Each of these systems exhibits the properties of irreducibility, temporal and spatial order, homeostatic self-stabilization and evolutionary self-organization. The coexistence of systems on multiple levels results in a highest-level system which is hierarchially organized. That structure is the totality of all systems, welded into systematic unity by means of their mutual self-stabilizations and self-organizations.

The concept of a multilevel hierarchy can account for the manifest diversity of phenomenal properties as well as the multiplicity of structures and functions consistently with the invariant framework of a general systems theory. Fresh qualities and properties can emerge in the form of new transformations of invariant systems attributes. The diversity of structures and functions can be shown to be the consequence of the manifestation of some recurrent basic function in particular variations corresponding to the hierarchic level of the system. Such nova are explained by the fact that systems at each level contain systems at all lower levels plus their combination within the whole formed at that level. Hence the possibilities for diversity of structure and function increase with the levels, and one need not reduce the typical characteristics of higher-level entities to those of lower levels but can apply criteria appropriate to their particular hierarchical position. The higher we raise our sights on the hierarchy, the more diversity of functions and properties we are likely to find, manifested by a smaller number of actualized systems. Thus atoms exist in greater numbers than molecules but have fewer properties and variations of structure; organisms exist m smaller numbers than molecules but have an enormously wide repertory of functions and properties and are capable of existing in untold variety of structural forms (the roughly one million existing species of plants and animals are but a fraction of all the possible species which *did* exist and *could* exist), and the number of ecologies and societies is smaller than that of organisms but already within their small population manifests greater diversity and flexibility than biological phenomena. It is evident that both the numerical and the functional differences are due to the hierarchical position of the systems on the various levels: many systems on one level constitute one system on a higher level, consequently higher level systems are less abundant and have a wider repertory of functional properties than systems on lower levels. Thus to claim that all systems exhibit invariant properties and types of relationships does not entail reductionism: the invariances express themselves in specific non-reducible transformations corresponding to the degrees of freedom proper to each level of the hierarchy.

Now, the concept of 'hierarchy', while much used in the contemporary natural scientific and philosophic literature, is seldom defined rigorously, and when it is so defined, it is often inapplicable to the phenomena for which it is most often used.[19] A rigorous definition implies a governing-governed or 'bossing' relation between levels, so that a diagram of a hierarchy becomes a finite tree branching out of a single point, without loops. Such hierarchies apply at best to military or quasi-military organizations with established non-reciprocal chains of command. But hierarchies have found their most fruitful application in nature, where rigorously unidirectional action is hardly ever the case. Hence in the present use the concept of 'hierarchy' will not be given its rigorous meaning but will denote a 'level-structure' or a 'set of superimposed modules', so constituted that the components of modules at one level are modules belonging to some lower level. Using the term 'system' for 'module', we can speak of a hierarchy as a level-structure in which the systems functioning as wholes on one level function as parts on the higher levels, and where the parts of a system on any level, with the exception of the lowest or 'basic' level, are themselves wholes on lower levels.

Systems belonging to a level below that of any chosen level are called "subsystems" in relation to the system of the chosen level, and the system belonging to the next higher level is a "suprasystem" in relation to it. The relativity of these terms is evident: a given system **a** may be a subsystem in relation to **b** and a suprasystem in relation to **c.** Merely that (**c** < **a**) < **b** is required (where < is a symbol of relative inclusion). Then **b** is a suprasystem in relation to a, and **c** a subsystem in relation to **b.** We can readily see how a theoretically infinite hierarchy may be constructed in this way. But if our postulates take account of the empirical world as their sphere of applicability, our hierarchy will be finite: although there may be a large number of levels of systems in the observable universe, there is no serious warrant for believing that the series is infinite. (Unless, of course, the universe itself is both infinite and hierarchical—but such an endless series of universes within universes boggles the mind.) Thus a more realistic task is to propose a finite-level hierarchy and identify each of its rungs with one predominant type of observable.

Attempts of this kind have been often made and, until relatively recently, came under the heading of an ontological category scheme (one of the latest major systems of this kind being that of N. Hartmann). More recently, this type of endeavor has been taken over by general systems theorists, who wish to establish similarities as well as differences between systems encountered in various empirical domains. Thus Boulding supplied key notions of a "hierarchy of systems" which Bertalanffy formalized into a table of system levels, theories and models, and empirical descriptions.[20] It includes both natural and artificial systems, e.g. both atoms, molecules and organisms; and clockworks, control mechanisms and symbolic systems. The hierarchy we are concerned with here is less inclusive than this, dealing only with *natural* systems, and more rigorous in one basic regard: its levels follow the hierarchical scheme of relative inclusion without gaps or redundancies. Thus we seek to order natural phenomena into a 'vertical' order wherein any given system, with the exception of those on the lowest or *basic* level and that (one) on the highest or *ultimate* level, is both a suprasystem in regard to its hierarchical parts and a subsystem with respect to the system(s) which it forms together with other systems in its environment. Hence, from the viewpoint of a system of level **n,** there is an *internal hierarchy* of its structure-functional constitution, made up of the hierarchically ordered series . . . $[(\mathbf{a} < \mathbf{b}) < \mathbf{c}] < \mathbf{n}$, as well as an *external hierarchy* consisting of the structure-functional wholes constituted by its environmental coordinations with other systems, $[(\mathbf{n} < \mathbf{x}) < \mathbf{y}] < \mathbf{z}$ . . . Since **n** is situated at the intersection of the internal and the external hierarchies, the number of levels in each defines n's specific position within the objective level structure in nature, ranging from atoms to ecologies and beyond.

A hypothetical identification of the principal levels and interrelation of the micro- and macrohierarchies. Note that the emergence of each higher level out of systemic structurations of units of the lower levels is contingent upon local conditions and results in the uneven build-up and distribution of modules of intermediate levels (-H7-- H1, including h6-- h) within the space-time manifold. (From Ervin Laszlo: *Introduction to Systems Philosophy,* op. cit.)

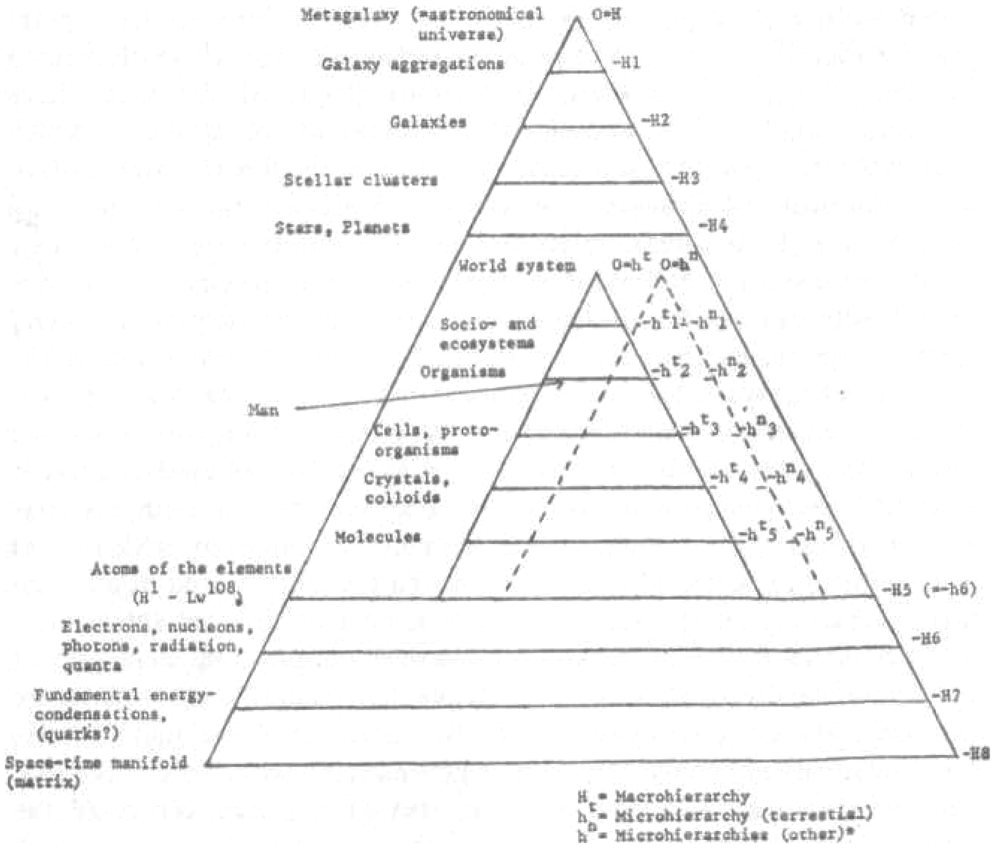

Fig. 2

* Form and evolution of upper levels undetermined.

If a hierarchy of this kind could be confirmed by empirical data, a basic ideal of science would be realized: the many entities investigated by the diverse empirical sciences would be plotted on a map of hierarchical organization and the theories applicable to them could thereby be interrelated. Such confirmation encounters serious difficulties at this stage of scientific development, as the uncertainties concerning relationships of wholes to parts emerge in all disciplines (e.g. is the ‘particle’ itself a system of more primitive units such as quarks; is a tissue a level below the organ, or above, or equal to it; is a community of people on the same multiorganic level as a beehive or above it, etc.). But empirical difficulties of identification do not adduce evidence for the inapplicability or falsity of the concept of a hierarchy of natural systems, only for the methodological and observational problems of confirming any given hypothesis about it. The hierarchy concept remains valid as a general system-concept in virtue of the part-whole relations evidently holding true in whatever area of natural phenomena one investigates. Nature, rather than resembling a machine with all its parts on a par, grinding out the observed phenomena, appears to constitute self-maintaining and self-organizing systems which, in mutual relationships, jointly constitute progressively higher levels of self-maintaining and self-organizing systems.

Atoms and organism, molecules, cells and societies—units of investigation which appear ordered in their own special way when approached within the framework of the special empirical sciences, reappear as units of the same general species in a generally ordered realm of nature when the special theories are integrated within the framework of systems philosophy. We may never know whether the 'real' world, that ultimate reality which surely underlies all our observations and constitutes our very existence, is truly ordered, and if so, whether it is divided into distinct types of special orders or manifests one overarching type of systematic order. What we do know is that the human mind seeks order and that the more general and simple the order it discriminates the more meaning it confers on experience. As long as no direct metaphysical insights into the nature of reality are available, we must reconstruct reality through rational theories with empirical applications. If our theories are optimally simple and general, and yet have optimal empirical accuracy, they are the most acceptable and deserving of the coveted title of 'scientific'. The thesis of systematics, "that understanding is possible because there is a world order that is reproduced in our experience through systems or sets of terms having universal properties"[22] is not a statement of indubitable fact (no statement about the empirical world is that) but an entirely valid hypothesis. It is fully shared by systems philosophy. The latter, together with systematics, should thus be the appropriate instrument for the development of understanding of man, experience, and the world in general. In systems philosophy such understanding is elicited by the integration of the findings of the empirical systems sciences by means of the invariances exhibited by their respective systems models. The here described basic constructs of systems philosophy provide the conceptual reference points for the discovery of such invariances and the consequent integration of empirical scientific findings.

For every set of enduring entities that comes about in the natural world must exhibit the basic properties of ordered wholeness, self-stabilization and self-organization, and hierarchization. These are the very conditions of systematic endurance in a dynamic universe. If we take them as our conceptual gestalt, invariant orders are revealed to us across a wide range of transformations. Atoms, organisms and societies share these invariant orders, and man finds himself in a world which is no longer a stranger to him. The implications of this new way of organizing experience and integrating scientific knowledge are tremendous. A broad and rich field of philosophic-scientific investigation opens up. Its exploration is among the most exciting challenges available to us today.

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6. See his remarks on "order" in *Towards a Theoretical Biology,* C. H. Waddington, ed. Chicago: Aldine, 1970, Vol. 2.

7. *Introduction to Systems Philosophy,* op. cit.

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9. Wholes may be more than the sum of their parts, e.g. in information content, qualitative diversity, function, sensitivity, etc.; and they may be less than their parts, e.g. in measure of entropy, thermodynamical equilibrium, range of variation, etc. The terms 'more than' and 'less than' are relative to the scale by which the whole is compared to its parts.

10. See the examples given by von Bertalanffy, in *General System Theory,* pp. 54f.

11. See *Introduction to Systems Philosophy,* op. cit. Bortoft brings to light additional applications of the concept in “The Whole: Counterfeit and Authentic”. *Systematics,* 1971, 9 (2).

12. A. Katchalsky and P. F. Curran, *Nonequilibrium Thermodynamics in Biophysics.* Cambridge, Mass; Harvard University Press, 1965, Chapter 16.

13. Ibid.

14. Ibid.

15. W. Ross Ashby, “Principles of the Self-Organizing System”, in *Principles of Self-Organization,* Foerster and Zopf, eds. London and New York: Pergamon, 1962.

16. Ibid, p. 272.

17. Ibid, p. 270.

18. Ashby himself seems to be aware of the difficulty in regard to living systems. He suggests that intelligence, as well as such phenomena as conditioning, association, learning (etc.) may be the result of a process where the input comes to a system with many equilibria. But such a system would be cogently defined, it would seem, not as an equilibrium system, but as one with a number of fixed internal constraints.

19. A case in point is Bunge’s formal definition in: *Hierarchical Structures,* Whyte, Wilson & Wilson, eds. New York: Elsevier, 1969.

20. von Bertalanfly, op. cit., pp. 28-29.

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