THERE IS A WAY TO MAKE GENERAL SYSTEMS THE UNIFYING FRAMEWORK OF THE SCIENCES

In 1956, Kenneth Boulding suggested that general systems theory should be the framework of science.

"General Systems Theory is the skeleton of science in the sense that it aims to provide a framework or structure of systems on which to hang the flesh and blood of particular disciplines and particular subject matters in an orderly and coherent corpus of knowledge.", (Boulding, Kenneth E. 1956. General Systems Theory—The Skeleton of Science. Management Science 2:3:197-208.)

He was correct. By their very nature, the principles of general systems should play that role. Nevertheless, they did not achieve that status. Boulding did not provide a way to make it so. It was as if Bertalanffy had presented the key, and while many could see the importance of it, none could see how to use it.

In the early seventies an examination of the literature showed the situation to be the same, and there was the question, Why? The answer was there—in the literature. There were no generalists. All the researchers in general systems had been trained as specialists. Each tended to view general principles from the vantage point of their own specialty, often naming them according to specialist paradigms or terminology. There was considerable confusion about the nature of the principles and the kinds of roles they play in the world at large.

The next question, then, was Why were there no generalists? There were several answers. First, the flood of knowledge produced by science had made it impossible to be a generalist in the traditional sense of knowing nearly everything in most areas of knowledge. There was nothing one could do, except become a specialist.

Second, although Bertalanffy had provided a clue many years earlier, there was still no one who knew how to use that clue to train a generalist. No university offered a course of study leading to a degree that represented achievement of actual generalist understanding. There were no generalists because there was nowhere to go to get that kind of training.

Because all the researchers were specialists, none of them had the breadth or depth of understanding to recognize those general principles that were the most general, those principles that tied the rest together into a coherent body of knowledge and understanding. This is a third reason why there were no generalists. General systems did not become the framework of science because it had not yet found its own framework. It was not a coherent body of knowledge.

In the context that it is impossible to be a generalist in the traditional sense, Bertalanffy's clue suggests that general understanding can be achieved by way of general system principles. Boulding's clue can then set one on the track of the framework of general systems, on the track of those factors of existence, organization, and change that are sufficiently general to relate each and every thing that exists to some other thing that has existed, exists, or will exist. Once someone has those factors, and recognizes the framework of general systems, then all else falls into place. And with such understanding, that person is a generalist. Not a generalist in the old sense of knowing virtually

everything, but in a modern sense of achieving the ability to understand anything, or everything.

The idea has been passed around that science deals with what and how, but does not concern itself with why. Setting aside the point that that idea is not particularly true, it should be understood that the type of knowledge a modern generalist works with is specifically about the why of things.

There are four necessary aspects of procedure required to find and understand those factors that provide the foundation and the core of the framework of general systems: (1) the prime imperative of analysis, (2) structural logic, (3) realist philosophy, and (4) a biological epistemology.

Intrinsically, general systems principles are factors that play roles in existence, organization, and change. They are factors of the nature of reality, factors that make it what it is. The prime imperative for the accurate analysis of the intrinsic nature of reality is to look to the subject of investigation itself. Let the intrinsic nature of reality dictate the understanding of reality. For the purpose of identifying those factors whose roles in reality universally relate one part to another, and thereby constitute the core of our understanding of general systems, its framework, it is necessary to let the intrinsic organization of reality dictate the organization of our knowledge and understanding.

The prime imperative means that you do not begin with speculation. A modern generalist does not begin with beliefs, assumptions, suppositions, postulates, hypothesis, or theory. Postulates, hypothesis, and theory in scientific method are used to guide further exploration, further looking at the subject of investigation. With correct scientific procedure they are derived from prior examination of the subject—look first, speculate second about what that first look indicates you do not yet know. In this context, it should be understood that theory is not the goal of science in that it contains speculation about what is not known in combination with what is known. Accurate knowledge is the goal of science, a correspondence between ideas about reality and the intrinsic nature of reality.

The term, structural logic, as used by a modern generalist refers to the manner in which the intrinsic qualities of things that exist determine the manner in which those things can interrelate. Structural logic is an intrinsic aspect of reality, an intrinsic aspect of that which exists. It is structural logic that determines the manner in which the qualities of the components of a whole interrelate to create the emergent qualities of the whole. Guided by the prime imperative, a modern generalist lets the structural logic of reality dictate the logical relations of concepts.

Because science and the field of general systems are about reality, the underlying philosophy must also be about reality. Realist philosophy is concerned with what can exist—in the past, now, and in the future. The philosophy of reality is an intellectual activity, one that relates knowledge one part with another. The epistemology associated with science, the field of general systems, and realist philosophy must be realist in nature. The raw data of knowledge comes by way of our senses, is then reworked by the brain, and finally experienced there. The senses, the brain, and the mind are all biological in nature. A realist epistemology, therefore, is a biological epistemology. As the senses, the brain, and the mind are all evolved entities, so too is knowledge an evolved aspect of reality. A biological epistemology concerns itself not only with the anatomy and physiology of the biological basis of knowledge, but also with its long-term origin, its evolution.

Further, to discover, understand, and effectively communicate those factors that constitute the core unification of general systems, it is necessary to avoid various approaches that interfere with the application of the prime imperative and that inevitably lead to error, such as (a) anthropomorphism, (b) thinking in the abstract in the sense of thinking about the relations of concepts rather than thinking about the relations of the reality referents of concepts, (c) any form of mentalism, idealism, or solipsism, (d) any form of Platonism, and (e) metaphor.

And now, to the framework of general systems. For a modern generalist, a factor is anything that exists that plays a role in the nature of reality. Space, time, and matter are factors, as is any form of relation, pattern of organization, or event. The factor that plays a universal role of connecting each and everything that exists with something else that exists, and that does so in an ordered fashion, is development. Development occurs in various forms—a few foundational universal forms, many developed less universal forms, and a multitude of forms that play roles in specific types of situations. The foundational universal forms are (1) extensional development, (2) existential-pathway-development, (3) factor development, (4) change development, (5) emergent development, (6) causal development, (7) through-flow development, (8) coherent development, and (9) situation development. Some general factors that play roles in foundational forms of development are (a) sequential-difference, (b) sequential enhancement, (c) determinate consequent-existence, (d) continuing-existence, (e) self-organization, (f) motion, (g) emergence, (h) combinatorial enhancement, (i) cause, (j) through-flow, (k) coherence, and (l) hierarchy. It is development, then, that can be used as the framework of the understanding of the existence, organization, and change of reality, that is, as the framework of general systems.

Reality is organized sequentially (and thereby developmentally), from place to place in space, from past, to present, to future with time, from stage to stage in processes, and from level to level with hierarchic material organization. Each of these sequential aspects of reality involves a transition from simpler situations, with fewer factors playing roles, to more complex situations, with greater numbers of factors playing roles. Development and the factors that play roles therein are foundationally extremely simple. The deepest foundations occur with space and time. The understanding of the core connecting factors of reality, and thereby of general systems, begins with the utter simplicity of space and time and builds up from there toward more complex situations and systems by way of additional factors and their roles.

Applying the prime imperative of the accurate analysis of the intrinsic nature of reality, observe a portion of space—that directly in front of you will do. Notice that it has the quality of extension. It extends from the left side of the portion all the way over to the right side. The left side is a different part of this portion of space from the part on the right side. These parts are adjacent to one another and organized sequentially, first the one and then the other.

Notice how the part on the left has its own left part and right part, as does the part on the right, allowing you to look at four parts of the portion of space in front of you. These four parts are organized sequentially with one another. Space is not made up of distinct individual units like matter. Instead, the parts of space blend into one another in a continuous manner. There is a continuous sequence of spatial part from the left side of

the observed portion to the right side. Note next that all parts of this sequence are coexistent. They are all there together at the same time.

Since each part is there simultaneously, coexistently, with the other parts, and since each exists at a different part of the portion of space under observation, each part is individually different from the other parts. The parts are coexistent, sequentially organized, and different one from another. The observed portion of space is a case of coexistent-sequential-difference. Consider now a row of objects on a table. The objects are coexistent, sequentially organized, and individually distinct, constituting a second case of coexistent-sequential-difference.

Beginning at one end of the row of objects and continuing on to the other end, there is an increasing quantity of objects along the row. There is just the one object at the end. Then, with the second one, there are two, and so on. Two is more than one, two is greater than one, two is an enhancement of the situation from just the one. Down the coexistent-sequential-difference of the row of objects there is a sequential quantitative enhancement, a sequential development of more.

The situation with the coexistent-sequential-difference of spatial extension is the same. From one side of the observed portion of space to the other it is evident that there is an increasing quantity of space. There is a sequential quantitative enhancement from the one side to the other, a sequential development of more. There are here two cases of coexistent-sequential-difference, that of space and that of matter, each with the qualities of enhancement and development. The row of objects on the table occupies space, with the coexistent-sequential-difference, the sequential enhancement, and the sequential development of the row of objects occurring with the corresponding coexistent-sequential-difference, sequential enhancement, and sequential development of the sequence of spatial place occupied by the objects.

The spatial case is the simpler, lacking the substantiality of the material case with its distinct units. Space is place, immaterial place. Matter occupies space, with space providing an existential context, a place-to-be, for the existence of matter. Without space, matter could not exist, as there would be no place for it to do so. Matter has an existential-dependency relation with spatial place. Space, then, is not only simpler in nature than matter, it is the more fundamental aspect of reality.

As space is simpler and more fundamental than matter, so also are its coexistent-sequential-difference and the associated development. In the spatial case the sequential difference, enhancement, and development are based on the extension of space. There are many different kinds of spatially organized material sequential developments, and all those material cases have an aspect of extension as an aspect of their intrinsic nature, as an aspect of their mode of existence. Extension is a factor of both spatial and material coexistent-sequential-difference. Extension is the core factor of this form of development—extensional development.

This form of development is foundational and universal. All cases of the organization of matter in space of whatever stage of development, from the simple to the complex, are cases of extensional development in that the fundamental spatial form is still always present and playing its role of providing a place-to-be for the material forms.

The next universal foundational form of development is existential-pathway-development. With the observed portion of space, from one side to the other of the sequential difference of the spatial extensional development, there is an aspect of

continuous existence. Something, spatial place, is there all the way across. With a long board, from one end to the other of the sequential difference of the material extensional development, there is again an aspect of continuous existence. Something, wood, is there from end to end.

The board occupies spatial place, with the continuous aspect of the material extensional development occupying the continuous aspect of the spatial extensional development. A mouse can run along the board, using it to get from one place to another. The mouse uses the continuous sequential difference of the material extensional development to get from one part of the continuous sequential difference of the spatial extensional development to another part, at the other end of the board. The mouse uses the aspect of continuous existence of the spatial and material extensional developments as a pathway. There exists there an extensional existential-pathway-development along which the mouse can run.

There is an aspect of continuous sequential difference to the running of the mouse along the board, and an associated development of the situation as the mouse progresses from one place to another. This is another case of existential-pathway-development, with many additional factors playing roles. It is no longer simple extensional existential-pathway-development, but rather a developed form. With existential-pathway-development, there is a quality of sequentially connected development, be it continuous extension (immaterial or material), or continuous change (as in running).

In this situation there are three forms of this type of development, that of the running of the mouse, that of the extension of the wood of the board, and that of the space occupied by the board. The spatial case is the simplest, existing only as a sequence of immaterial spatial place. The material case is developed in that there is now the additional role of the substantiality of the wood. In these cases change does not play a role, however, it does so as an additional factor in the case of the running mouse.

These three cases of this factor, existential-pathway-development, differ from the simpler to the more complex by way of additional factors. This is factor development. It is common in the existence, organization, and development of reality for factors to occur in simpler forms in simple situations with fewer factors playing roles, and to occur in developed forms in more complex situations where there are additional factors playing a greater diversity of roles.

To find the simplest and foundational form of the next type of development, change development, it is necessary to go back to space. Space exists—and it continues to do so. Pass your hand through the observed portion of space, noting that the space continues to be there the whole time your hand is moving from one part to another. Note also that the parts of the continuing-existence of that space are not coexistent. Your hand passes through one part of the portion of space during one part of the continuing-existence of the space, and passes through the other part of the space during a different, following, noncoexistent, part of the spatial continuing-existence. The continuing-existence of space is a form of change, with following part coming sequentially and noncoexistently after the previous part. This is noncoexistent-sequential-difference—change.

The continuing-existence of space is continuously ongoing, with an ever increasing amount of the continuing-existence that has occurred. Increasing amount by way of noncoexistent-sequential-difference is a form of development, change

development. The change development of spatial continuing-existence is foundational and universal first because space is infinite, and second because everything that exists does so in space, with the continuing-existence of each and every factor or thing that exists occurring with, and conforming to, the continuing-existence of space. The change development of spatial continuing-existence forms a core element of the framework of general systems because it plays a role in the existence and intrinsic nature of all more development forms of change. It does so because spatial continuing-existence is the reality referent of the term, time.

Emergent development is next. When two or more units are coexistent in space, there are direction and distance relations between them. The group of units and these extensional relations constitute a pattern of material organization. When one of the units moves, it acquires different direction and distance relations with the other units. The pattern of organization of the group changes. A new pattern of material organization comes into existence—it emerges.

This is the development-of-origin for emergence, the simplest form in which it is known to occur. Like other factors, emergence develops, occurring in simple form in simple situations and in more complex form in situations with more factors playing roles. At whatever stage or level of the development of reality where emergence plays a role, a newly existing pattern of material organization comes into existence, be it a newly formed atom within a star, a seed in a pod, or a galaxy. This occurrence of an emergent pattern of material organization is a form of development—emergent development.

Next there is causal development. When a moving unit of matter collides with a stationary unit, the moving unit pushes against the stationary unit. This push is cause. Cause is push, with this simple case being a development-of-origin for cause. When a unit of matter moves in relation to another unit, the pattern of organization of the two units changes as a consequence of the motion. When one unit collides with another, there is again a change in the pattern of material organization of the units. This time the change is a consequence not only of the motion, but also of the push. The change in pattern is pushed into existence, forced to occur, caused to occur.

The occurrence of an emergent pattern of material organization that is pushed into existence, caused to occur, is a form of development—causal development. Like emergence and most other factors, cause develops, becoming more complex with the roles of additional factors. At whatever stage of the development of reality, though, at whatever level of the hierarchic organization of reality, whatever the degree of complexity of a causal situation, at its core there will be the role of push. That is why causal development is a factor of the core framework of general systems.

Something of particular significance happens when matter pushes against other matter. The matter receiving the push gives way—it begins to move. It is this caused motion that results in the new caused pattern of organization. What is significant in this situation for the next form of development is that the matter delivering the push slows down, loses motion, while the matter receiving the push gains motion. Cause involves an energetic transfer, an energetic through-flow from matter to matter. The occurrence of the acquired motion is a development of the situation due to this energetic transfer, and this transfer situation is a development-of-origin for through-flow and through-flow development. Through-flow development is a particularly significant factor in the

framework of general systems because it plays required roles in the creation of systems, their operation, and their maintenance.

Matter bonds to other matter, resulting in coherent development. With this form of development, there are developments of hierarchy, diverse material form, and stable coherent pattern of material organization. Each of these factors are required for the existence and functional aspects of systems. The complexity of systems develops with the developments of coherent hierarchy, form, and stability.

A final example of a foundational form of development that plays a universal role in the nature of reality, and thus in the overall framework of general systems, is situation development. Every individual elementary particle in the universe, as it moves through space and continues to exist with time, undergoes a unique intrinsic existential-pathway-development. These particles interrelate with one another in a variety of ways, from bouncing off in collisions to tight coherent bonding. As they do so, their existential-pathway-developments interrelate, combining momentarily before the particles bounce away, or progressing jointly in coherent bond. The ongoing interrelation of existential-pathway-developments is situation development.

It is characteristic of elementary particles to combine into increasingly larger clumps—atoms, molecules, macromolecules, organisms, crystals, rocks, continents, planets. As all these various clumps of matter move through space and continue to exist with time, they each have a unique intrinsic existential-pathway-development. The units of matter that exist, from photons to stars, interrelate with one another in a variety of ways, from bouncing off in collisions to tight coherent bonding, with a vast diversity of modes of interrelation in between. As they do so their existential-pathway-developments interrelate.

All the units, from particles to stars, are there together, coexistent. All their existential-pathway-developments are at what is the current stage for each. The units together constitute the current situation, and the combined current stages constitute the current state of the continuously changing situation. Situations develop as the existential-pathways of their various interrelating components develop. The existential-pathway of a situation develops as the existential-pathways of the components develop together.

As a unit of matter is moving through space, it is passing through the coexistent-sequential-difference of spatial extension. The unit is moving along the extensional development of space. Also, as the unit continues to exist, it does so with the noncoexistent-sequential-difference of spatial continuing-existence. The unit is continuing to exist with the change development of spatial continuing-existence. Both spatial extensional development and the change development of spatial continuing-existence play roles in the existential-pathway-development of the moving unit.

At the development-of-origin of emergence, the existential-pathway-developments of all the units of matter constituting the emerging pattern of material organization are playing roles. Emergent development plays a role in the development-of-origin of causal development, and causal development plays a role in through-flow development. It is common for prior stages of development to continue playing roles in the origins and continued existence of later stages. Thus, in situation development usually all prior foundational forms of development are still there continuing to play their roles.

A system is a situation. It is a group of interrelating units of matter, which are often from a variety of hierarchic levels of organization, with the combined current stages

of the various existential-pathway-developments constituting the current state of the system. The ongoing operation of a system is a consequence of the ongoing interrelations of the existential-pathway-developments of the components of the system.

Systems exist in space, change with time, and are made out of matter. Systems are patterns of material organization. They are composed of elementary particles, which become organized into atoms, which are patterns of material organization. Atoms, apparently, are little systems, their component protons, electrons, and neutrons having bonded into a clump of matter that continues to exist during time and that moves through space as a unit, a hierarchical whole composed of interrelating parts. Atoms bond together into molecules, a higher level of hierarchical pattern of material organization, and molecules join together to form more complex molecules, crystals, and a seemingly endless variety of substances or materials of varying degrees of complexity, which can recombine in increasing levels of hierarchic organization. Complex groupings of matter often have both coherently bonded units and loosely interrelating units as components of the overall pattern of organization of the situation.

All groupings of matter are patterns of material organization. Many of these patterns are persistent, for example asteroids and pennies. Systems, however, are more than just patterns that persist. They are both persistent and dynamic, maintaining their identity despite significant ongoing change. A number of factors have been discovered that play roles in the persistent stability of systems—through-flow, homeostasis, feedback, self-organization, and adaptation to name a few.

These factors occur in various forms in different types of systems, often in simple form in simple systems and in more complex form in complex systems. Like the systems of which they are structural/functional components, the factors that play roles in the existence and intrinsic nature of systems are themselves patterns of material organization. Like most factors of the existence and organization of reality, they develop, and this development can be mapped. Think of all the forms and levels of feedback that play roles in the functioning of a human body, from the molecular levels within a cell, through the hormonal systems, to the overall control of the body by the nervous system.

It would be an interesting research program to map all these cases of feedback. There are probably hundreds of them, of many different types. What would show up in the results of such an investigation is that different types of feedback play different types of roles in the functional processes of the body. Knowing that would provide a deeper, more accurate understanding of the physiology of the human body, from the molecular biology of the cell all the way up to the body as a whole. Think of how useful that knowledge would be to microbiologists and physicians. What if they had access to that kind of understanding for all the general factors that play roles in many different systems? These general factors in their various forms play roles that provide different types of systems their distinct characters.

A number of general systems research programs could be planned by way of this approach that would result directly in practical information for the management of complex systems. Overall it would be a project that identifies and maps factor development within the general development of reality, and more specifically from the more simple systems to the complex systems. For example, at this level a general systems researcher could track down the development of some particular general factor from its simplest developments-of-origin, wherever they might occur, on up through the various

levels of the organization of material reality, in both abiotic and biotic situations and systems. In this project the researcher would be following the development of the factor of interest up through the various disciplines, such as from physics or chemistry up through geology or biology.

Another, more restricted project, would be to find and display all the different forms and stages of development of some general factor within a very complex system, such as the roles of feedback in human physiology as mentioned above, or in an ecosystem such as a forest, a grassland, or a coral reef. A large but still limited program would be to map out all the known general factors playing roles in a specific type of system, for example within a single cell. Perhaps mapping out all the known cases of a certain general factor within a simple organism, a bacterium or an alga for example, could be the basis of a graduate thesis.

The compliment of all this exploratory work would be to bring all the results together in one coherent body of knowledge. The product of this synthesis would be a map of the development of reality, and of all the various types of systems therein. This synthesis would be, quite literally, the framework of general systems.

It is well known now that specialization in the sciences has established artificial barriers in understanding within the hierarchy of the disciplines from level to level, from physics up to sociology. There is, therefore, one more component of the modern generalist worldview that is needed here, a factor that goes beyond showing how general factors play roles in the various disciplines, a factor that specifically plays the role of unifying the sciences into a single integrated body of knowledge. That factor is emergent development. The chemical world is emergent from the world of physics. Geology and biology, the reality referents, not the sciences themselves, are emergent from chemistry. The higher levels of the hierarchic order of material reality are emergent from the lower levels.

Up to now, emergence has been considered more mysterious than not, with claims of unpredictability, non-reducibility, the requirement of unique novelty, and so on. These are anthropomorphic attitudes about emergence, and not actual qualities of real cases of emergence. Emergent development is a consequence of interrelating existential-pathway-developments. The manner in which emergent properties and wholes come into existence can be figured out by carefully following those interrelating pathways of development. This presents another realm of research opportunities. For cases that are not overly complex, graduate students can analyze and map out in continuously connected detail the manner in which the intrinsic qualities of the components of an emergent whole determine, within the context of their manner of coming together, exactly how the interrelating existential-pathway-developments create the emergent whole. Research teams can tackle the broad scale emergent transitions from one level to another, from one science to another.