Prolegomena to any Future General Schemas Theory

CHAPTER 2

The Foundations of General Schemas Theory

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Central Concept

The central idea of this dissertation is very simple. The idea is to go through the sciences and find all the schemas that have been developed in the special sciences and to generalize them interdisciplinarily and transdisciplinarily just the way that the systems schema has been generalized by Systems Science, and then to compare and contrast all of these schemas with each other in order to develop a meta^2-discipline of the generalized schema per se. We posit that the generalization of the schema from the special disciplines is a meta-discipline and that the higher level generalization of the schema across all the schemas is a meta^2-discipline. The aim of this essay is to develop this second order discipline of the schema per se which looks across all the generalized schemas and attempts to understand them all together in relation to each other and to the other fundamental sciences like logic and mathematics.

Why this has not been done previously is a mystery to the author. The fact is that the only schema that has been generalized in this way so far is the "system" schema. So we wish to take that as our paradigm for the generalization of all schemas. Until all the schemas have been generalized in this way it will be difficult to compare and contrast the various schemas or relate the schemas to other fundamental human sciences like logic and mathematics. One would have thought that this research horizon would have already have been actively exploited since it is clear that it is possible to isolate and generalize the system schema one would think that it is only natural that the other schemas would already have been isolated and generalized. But this is not the case. In fact, Systems Science has not been a complete success from an academic point of view. There are very few departments of systems science in the country. Such Interdisciplinary and Transdisciplinary work goes against the basic bias towards specialization within academia. Systems Scientists must do their generalizations from within a particular specific discipline and there is no support for anything other than institutes and centers of systems science for the most part within the academy, at least in the United States. Systems Science also seems to have lost its momentum as new discoveries of Complex Systems and Adaptive Agent Systems have produced their own centers, institutes and societies rather than building on earlier work in Systems Science. Therefore, because the pursuit of Systems Science as a unified discipline has stalled and been fragmented across disciplines, it was difficult to justify and pursue similar generalizations of other schemas. It is not clear that anyone ever thought of a generalized meta^2-discipline of the schema before. However, the search for precursors in this area will not stop because it is very likely that such precursors have existed before. But as far as I can tell there are no precursors at this time for this idea of a general schemas theory.

Let me explain how I came to have this idea. It grew out of numerous discussions in various email lists in which I participated where there seemed to be a fundamental confusion between ontic and ontological emergent hierarchies. So often people would take their projections of schemas to be objective realities out in the world rather than as projections. And also different people would project different schemas on the same phenomena and see quite different organizations. So many aguments were completely fruitless because one person was projecting one schema and another was projecting another schema and thus they would be talking at cross purposes to no end. It occurred to me that it would be worth while to attempt to separate out the ontic and ontological emergent hierarchies and to posit a set of ontological schemas in juxtaposition to the ontic emergent levels of phenomena discovered by science when reductionism failed. Similarly ontological emergent levels stand only when skepticism fails. Skepticism being very different from reductionism that gives us some of the sparation between the ontic and the ontological hierarchies. On one side are the emergent levels of the phenomena which cannot be reduced, and on the other side are the emergent levels of the projections of templates of understanding which resists skepticism. If we have a model of the ontological hierarchy as separate from the ontic hierarchy then it is possible to understand the difference between our projections and the phenomena we discover when we go beyond our projections and uncover the nature of the phenomena beyond our preontological templates of understanding. So the first draft of the schemas as a hierarchy was only meant to disambiguate arguments in which ontic and ontological hierarchies were mixed up or when different ontologocial levels were projected on the same ontic level in discussions on email lists in which I had engaged. One of the lists on which this discussion took place was between Ed Bailin and me on the Systems Engineering email list that I hosted prior to the formation of INCOSE email lists on Systems Engineering.

Briefly we can recite the history of schemas within our tradition. From the beginning of the tradition up to the turn of the last century there was only one schema of any consequence and that was the “form” schema. During the last century two other schemas gained prominence each adjacent to the form schema in the ontological hierarchy. One of those schemas was the pattern schema which flourished under the rubric of Structuralism. The other schema was the system schema which flourished under the rubric of General Systems Theory. Both Structuralism and Systems Theory allowed their schemas to gain some independence from the special sciences which used these schemas and some consideration was given to both of these schemas as to their nature independent from their appearance within specific disciplines. However, both of these movements had a certain life span which eventually waned and they lost their momentum as disciplines in their own right. We moved on to post-structuralism and to complex adaptive systems theory within our intellectual historical development and those who attempted to develop these schemas into general approaches to phenomena began to appear antiquated and passé.

But as far as I know no one went to the next step and to begin wondering about the nature of the schema in general nor to posit what the hierarchy of all the schemas might look like. One thing that did happen is that certain theorists in Systems Theory like George Klir tried to develop a structural systems theory which he did in his book <u>Architecture of Systems Problem Solving</u>. However, this was an extension of systems theory by adding in aspects of other schemas like structure and form. It did not consider each schema in its own right and their combination. However, this is a valuable contribution of our understanding of the relation between the schemas which is a vital step toward the development of a more general theory of schemas.

My own approach was speculative. I decided to try to posit what the hierarchy of schemas might be. Having read widely in the sciences I attempted to think back to the various schemas that I had encountered over my scholastic career and attempt to arrange them in an emergent series. The goal was to make each leap from one emergent level to the next about the same distance. After some trial and error I came up with the following hierarchy:

- Pluriverse
- Kosmos
- World
- Domain
- Meta-system (Open-Scape)
- System
- Form
- Pattern
- Monad
- Facet

I call this the ontological emergent hierarchy of schemas which are templates of understanding of phenomena which are projected on things out in the world by science in particular and socialized individuals in general. I don't claim that this is the final theory of the schema, but only that it is a candidate theory that can be tried out in order to see if other schemas appear. All schematization should be covered by these schemas and the special schemas that appear as thresholds of partiality between these schemas. This hierarchy is distinguished from the ontic emergent hierarchy which might be posited as follows . . .

- Gaia
- Social
- Organism
- Organ
- Multicell
- Cell
- Macro Molecule
- Molecule
- Atom
- Particle
- Quark
- String

There are different possible ontic emergent hierarchies discovered by science. They are what is left standing as *sui generis* phenomena when all attempts to reduce phenomena have failed. Different scientists will recognized different ontic levels. But the key point is that any one level may have multiple schemas projected upon it. Schemas are projections onto the ontic phenomena and are not inherent in the phenomena itself. So a cell can be a system, or a form, or a structure and if you look at it through any of these lenses then you will see a different sort of organization within the phenomena as different aspects of the phenomena are highlighted from one schematic projection to the next. Some schemas fit better some phenomena than others. But normally adjacent schemas can be projected on the same phenomenal level giving some interesting effects. However, depending on the scale of the phenomena certain schemas may not fit very well onto the ontic phenomena which is being projected upon. In general schemas nest inside of each other so that we can transition from one schema to another easily considering different emergent levels of the phenomena as aligning with the various higher or lower order schemas. But the emergent hierarchy of the schemas is essentially different from the emergent hierarch of the phenomena. Schemas are abstractions and they always gloss what ever phenomena that they are projected upon. They may help or hinder the observer getting a hold of the essence of the phenomena being observed. They offer more clues as to what is going on with our cognitive attempts to grasp the phenomena than they give us clues as to what is going on with the phenomena itself in itself. However, disentangling the ontic hierarchy from the ontological hierarchy and recognizing that multiple ontological schemas can be projected onto the same ontic level of phenomena helps us understand better scientific discourse, because we can recognize the schemas that the scientist or engineer is using to project on the phenomena under consideration then we can make structural transformations between these various ways of looking at the phenomena and thus better understand what is at stake in the various discussions of phenomena which are based on different schematic levels when talking about exactly the same ontic phenomena.

What is strange is that this sort of disentangling of ontological schemas does not seem to have been attempted before, and no one seems to have attempted to speculate about the makeup of the schematic hierarchy before separating it from the ontic hierarchy. Once we have made this leap to a level of attempting to understand the schemas as a whole set then we can begin to see the usefulness of the schemas beyond merely clearing up augments about phenomena from different viewpoints. We can see that the schemas open up a new horizon of research beyond the generalizing of all possible shemas. Each schema can be seen as a figure on the ground of all possible schemas. The relations of schemas to each other open up new vistas in our understanding of phenomena because these schemas are our jumping off place for understanding the phenomena. However, we must be careful we do not merely reduce all phenomena to the schemas. Rather we must see though our projections to the phenomena itself which appears as through a glass darkly beyond our pre-ontological understanding of the phenomena through the outline or template of understanding that the schemas provide a priori.

The key concept of this work is to develop the idea of the schemas as a discipline in its own right. It is hard to understand why this has not been done before. Perhaps some obscure scholar in our tradition, or some untranslated work holds the key to the founding of the science of General Schemas Theory, or Schemas Science. But until we find that precursor we are left to our own devices to attempt to found this second order meta-discipline beyond general systems theory. One of the reasons that this is necessary is that the word system is used to cover too many things and is tending toward meaninglessness. One reason we are forced to develop the idea of General Schemas Theory is to give the term system meaning again by its comparison to the other schemas. Only if we know what the other schemas might be can we use the term system precisely. So even if we are only interested in developing one particular schema out of the set, like the system for instance, we still need schemas theory as an auxiliary discipline to give the term "system" a definite meaning among its diacritical counterparts.

When we wonder about the term Schema itself and its meaning we are very fortunate that Umberto Eco has written the book <u>Kant and the Platypus</u> which is a survey of the meanings of the term schema. Because this book exists we can forgo a historical survey of the use of the term here. Rather we can point to his definition of the geometrical or mathematical schema as the one that we mean in all cases. In other words we use the term in a very precise sense as defined by Umberto Eco in his survey which indicates the geometrical or mathematical definition of the spacetime envelope of a thing. In this way we use the precise definition provided for us by Umberto Eco to define precisely what we mean by the term "schema," and we give examples in terms of the various named schemas in the ontological hierarchy provided above. As we continue our journey we will give more precise definitions of each particular schema in the hierarchy. But what we want to do here is start off in a very general way to define the enterprise in which we are engaged and its differences from other prior enterprises. In our view formalism in all its guises falls under the schema form and it offers proofs. Structuralism on the other hand falls under the schema pattern and offers explanations. Systemism if we can coin such a term falls under the schema system and as such offers only descriptions. These are the three well known schemas that have been developed most within our scientific tradition in specific disciplines. But our point is that they are not enough in themselves to cover the entire gambit of what is needed to be covered by the umbrella term "schemas." Rather we need a set of nested templates of understanding that takes us from the very small to the very large in discrete emergent steps providing an emergent organization that is different at each step. These steps must be the right distance apart, and each one must be "formally" represented, we might better say "schematicly" represented, in such a way that its organization is clear and discrete and fits into the niche of the next higher schema in such a way that no gaps are left over. Thus part of schemas theory is the survey of the sciences looking for new schemas that are in use in a particular discipline, but another part of schemas theory is checking the internal nesting of one schema into the next so that we can be assured that nothing is missing and that we get a good coverage of the phenomena at all scales.

Once we begin to understand what schemas are and how they fit together and form an emergent hierarchy which is scalable to the phenomena then we can begin exploring the horizon that schemas theory opens up to us beyond the horizons of the specific sciences, or beyond the generalization of any one particular schema. Rather we are opening up the field of interlocking schemas at different scales. By relating schemas to each other we get better information about the schemas than we would by merely studying individual generalized schemas. In fact we enter a whole new realm which we might not have expected which has very interesting features that few have encountered before. Here we will be concentrating not so much on enumerating the schemas and proving their nesting as we will be speculating and generalizing about the nature of the entire field of schemas. We see this work as opening up a new frontier and exploring the implications of the possibility of a general schemas theory, rather than the attempt to nail down once and for all the final theory of schemas. Our hierarchy of the schemas is a hypothesis. Other schemas may be out there to be discovered. We should look hard for them and if we find them then much that is in this work may have to be revised. But the opening up of the problematic of the schema itself will not have to be revised as various solutions are proposed and are replaced by newer solutions within the schematic field. Since our emphasis will be on the implications of the problematic, i.e. the foundations of General Schemas Theory rather than the specific hierarchy of schemas proposed here as a test case we are hoping that our work is an invitation to other researchers to enter this new field and make their mark on it, rather than presenting a closed and finished work in which all the ***t***s are crossed and ***i***s already dotted.

Our belief is that this realm of schemas theory is a new type of horizon of research where many new schematics will be discovered just like we discover new logics or new mathematical categories. The entire field of schematics is liable to be very complex once we eventually understand it. So we can consider this initial hierarchy that is proposed only as a strawman which is set up mostly to show that different schemas exist with different types of organization and that they nest into each other and have all sorts of interesting mutual relations. We believe that once the full range of schematics is understood that it will have far reaching implications for many disciplines. Our immediate interest in schematics is to give a grounding to various extensions of General Systems Theory which forms the basis for Systems Engineering as a pracitical discipline. But we believe that once the place of the schemas have been secured within our overall relation to things within the ontic hierarchy that the impact will be to ground science in general out of an obscure part of the philosophical tradition that was neglected from its inception and this neglect has caused all sorts of problems in our tradition which might had been avoided if we had understood the importance of the schemas earlier.

Meta-commentary

One thing that will free this work to be a meta-commentary on the Foundations of General Schemas Theory is the fact that working papers have been written on the details of the theory that are exhaustive. Thus we will make use of these working papers to pre-ground some of our discussions so that we can concentrate on the salient points and can approach the subject in a way that concentrates on the open horizon that the General Schemas Theory makes possible rather than plunging into details too soon which might obscure the argument. So for instance if you are wondering what is meant by these particular schemas and what more understanding of their intricacies then the series of working papers called the anti-thesis which goes through the series of the schemas one by one and talks about each one's relation to the whole series can be consulted. If on the other hand one wants to delve into the mathematical foundations of General Schemas Theory right away one can go into the series of papers on the Mathematical Foundations of the Schemas. On yet another front if you want to know more about how the schemas appear in the Western Philosophical and Scientific tradition then one can consult the papers that carry out a genealogy of the term in relation to the various philosophers within our tradition (unfinished). If on another front one wants to understand the relation of the schemas, especially the special systems schema to science in general then one can peruse the series of papers on nondual science. All these avenues are open for exploration to the reader, and this leaves us free to develop the concept of the schema in a way that will be most useful for understanding its foundations within the context of science and engineering in general. Of course, we will mention some of these points in the course of our survey, but some we may only mention while others we may rehearse in detail, but in general the meta-commentary presented here will keep its eye focused on the attempt to open up the horizon of research into General Schemas Theory to others in a way that will be most helpful in understanding the significance of this new approach toward science and engineering.

Framework

The best way to begin is to establish a framework within which to understand the import of the schemas. This framework has already been elucidated so we will be rehearsing and exploring it again here in a summary fashion. The first thing is to begin by distinguishing between Logos and Physus. These two Greek terms stand for the unfolding of speech, thought and reason on the one hand and of natural things on the other hand. This opposition has been flattened out by many more modern dualisms such as mind and body, consciousness and matter. We prefer to use the original Greek terms in order to retain their semantic depth. The nondual associated with this duality that stands between and prior to its differentiation is nomos or order. Once we have distinguished between Physus and Logos and their Nondual Nomos then we ask a key question as to the nature of the *physus of the logos* and the *logos of the physus*. The physus of the logos is fairly easy as that must be logic. Logic is the almost physical constraint of the rules undergirding rational speech and thought, which if we breach we enter the realm of nonsense. It is easy to see that the nomos of the nomos is Mathesis. We don't expect the nomos to interact with the duals because it is a nondual. Ordering of order produces the mathematical categories as we know them and as they have developed over the last century. So the only question we have left is regarding the nature of the logos of the physus. How does the physus speak to us? We know that the physus speaks to us via anomalies that factual, causes theoretical, paradigm, episteme or ontological shifts in our way of approaching the phenomena. The phenomena speaks to us when we get results from our experiments that we do not expect, for instance in the case of the Michelson-Morley experiment that told us that there was no such thing as ether in the universe despite the fact that light can act as a wave. This brings up the question as to whether logos has to speak to us using human language, or at least be expressible in human language. In other words, do the things have to ultimately make sense as Einstein thought they should? This is an open question. But who can deny the eloquence of the Michelson-Morley experiment which Einstein interpreted to give rise to his Special Relativity Theory. We were projecting something called ether on nature, and the experiment fairly non-equivocally told us that this projection was false. In such an experiment the silence of nature has a certain eloquence which it indicates in its repeated experimental results. That silence of nature being just as it has always been before and after the experimental question was asked, acting just as it has always acted in similar situations, is difficult to deny the dignity of logos. And this is another reason to use the greek term because it also means reason. Which is to say that nature acts is a way that is in concert with its own nature, i.e. in a reasonable fashion based on its own internal relations with itself. The nature of nature is always and everywhere the same and it acts according to its own inner reason in all cases, rather than randomly or precociously. Our science counts on that. Our science counts on the fact that nature has its own reasons which may be hidden from us but is always the same everywhere if we can only discern it by our experiments guided by our theories.

I want to give the name Schemas to this logos of the physus. That is because we anthropomorphize nature and we project logos upon it and that projection is first and foremost in the form of the mathematical and geometrical schemas that we see as the spacetime envelopes of the physical things. If we accept that at the second order level that the duals of physus and logos and the nondual nomos becomes articulated as mathesis, logic and schematics then we have produced a framework within which we can understand what a schema might be. We can understand the schemas as the projection of spacetime envelopes that are describable by geometry, topology and mathematics in general on the things. But the schemas are also logics of the things, which is to say organizations of the things that we project upon them a priori. Schemas combine within them the embodiments of the formalism of logic and the definitiveness of topological and geometrical mathematics into templates of understanding that we project on the things. In our culture we have developed mathematics and logic into high arts that are the pride of our civilization. But we have left the term of the schema in obscurity. We have no science of schemas corresponding to the sciences of mathematics and logic. And this is the root of many problems in our encounter with things both as found in nature and which we artificially construct. Many of these problems show up in Systems Engineering which is where the responsibility for emergent effects in large scale systems is vested. But problems also show up in the way that Science and Engineering in general relate to nature because of our lack of a schematic science.

Here we will consider just one of these problems that come out of this framework. One problem is the fact that we have a set based mathematics and syllogistic logic. In fact, in other parts of the world there are mass-based (non-count) based ways of approaching things and a well developed pervasion logic such as existed in ancient India and China. Our own tradition is lopsided in this respect since Aristotle's <u>Discovery of Things</u>. It was not just the principle of excluded middle and non-contradiction that Aristotle bequeathed to our tradition but also a bias toward sets and their logic. If we instead recognize that we need a mathematics that is mass oriented to balance our set oriented traditional mathematical categories and we need a pervasion logic to balance our syllogistic traditional logic, then the question arises as to how this would effect the schema. Schemas are definitely set-like approaches to anthropomorphic scaling. This means that there is something mass-like that is missing at the third corner of our framework that has not been missed until now. We have noticed that the physus itself is seen as an ontic emergent hierarchy. The logos of this physical ontos we have named the schemas which are projections. Could it be that the ontic hierarchy is in fact this mass-like characteristic. Notice that language is mass-like and that logic is set like. So we might expect a reversal at the other side of the duality where the schemas are set like at the meta-level and the ontic hierarchy is mass like at the level of the physus. Physus suggests something that is unfolding and growing which is a mass like behavior. When we look at the ontic hierarchy which ever one we accept then we are looking at the emergent effects which are mass like effects at a specific scale. The set like differences between schemas are more essential in nature. Ontic emergent differences are more to do with the behavior of masses at a particular scale having emergent characteristics. So suddenly there appears to be an explanation of the difference between the ontic and ontological hierarchies. The ontic hierarchies are mass-like ways of looking at emergent effects in things. But these mass like emergent effects speak to us through the schemas which we project on them which has a set like quality. The same thing is true on the side of language, which is mass like and which we confront with a set like logic in order to produce finitude in the face of infinitude. Similarly the schemas produce a finite gestalt of the seemingly infinite ontic arrays at the various emergent layers. In both cases we use mathematics in order to understand more abstractly the relation between the extremes of finitude and infinitude.

The schemas in both the case of logic and mathematics give us the spacetime envelopes that are our references to which our logical and mathematical models are related. If we had no schemas then there would be no way to relate either our mathematical models or logical models to existence as such. When we use an existential operator in Logic then we are referring to something that has a spacetime envelope which it fills. When we build a mathematical model the parameters of that model relate to measures of things that have spacetime envelopes. Without this reference to schemas there would only be free floating models in either math or logic which would in fact be meaningless in themselves. So schematization is very important. Thus it is particularly surprising that no science of schemata has ever been formulated. Rather only particular schemas have been posited in particular sciences to deal with particular phenomena, but except in the case of “systems” these particular schemas are rarely generalized. Our framework shows that there is a lopsided relation between the strength of Logic and Math on the one hand and Schemas on the other. This weakness of the schema makes it difficult to understand how our models relate to existence as such and causes our tradition to have an idealist character. But even materialists are idealists with respect to schemas because they have not developed a science of schematization either. So it is left to us to try to do so and see what the consequences of developing such a theory might be.

The relation between logic and mathematics is clearly delineated by Mathematical Model Theory. That is the theory of the logic of possible statements about mathematical categories. Our example of such a theory is that given by Chang in his book Model Theory. The inverse of this relation is the mathematical category of the Topoi which is the mathematical form of Logic itself. With the work of Russell the program of reducing mathematics to logic has been vigorously pursued. On the other hand with the work of Godel it becomes clear that the reduction of mathematical systems to logic will not ever be completed. So the best we can expect is that the bridges of Model Theory and Topoi will allow us to traverse back and forth between logic and mathematics giving us a good bridge between them. However, when we stretch from logic and math toward schemas things become less certain and more ambiguous. Between logic and the schemas we have the Philosophical Categories which are the highest concepts. Aristotle produced the first set of Categories and these were later improved by Kant and more recently we have the attempt by Igvar Johansson, but the categories have not been well developed in our tradition and there is still much doubt about the highest concepts. Interestingly in Kant his Schemas are directly related to the Categories as their temporalization. On the other hand when we move from Mathesis to the schemas there is representation theory which is developed somewhat in Mathematics as the many possible representations of a mathematical category. For instance a group may have many possible representations, the octonion for instance has 480 different representations. Representations are the various ways the fundamental relations between elements of the mathematical category in question can be embodied. The schemas represent full embodiment in spacetime. And the philosophical categories discuss the fundamental relations that these spacetime embodiments can have in relation to each other. But both Logic and Mathematics produce glosses on the external relations between these spacetime envelopes. It is schematization itself that describes the inner relations within the spaceitme envelopes. Thus, without a theory of schemas we have no precise concept of the inner articulation of the spacetime envelopes that the logical and mathematical models refer to. But also representation theory and philosophical category theory are not well developed so even if we have a good model of the schemas themselves we have to work on their relation with logic and math by strengthening these bridge theories.

Meta-Level Organization of the Schemas

Once we have located the schemas in our framework based on the dualities of Logos and Physus and the Nondual of Order, and seen that there is an intrinsic relation between Logic, Mathesis and the Schemas, and thus have established a framework within which we can locate the schemas, then it behooves us to begin looking at the organization of the schemas themselves. From the Mathematical Categories the schemas inherit there own internal organization which differentiates them from each other across a spectrum of nested scales. From Logic the schemas inherit higher logical type theory of Russell as their organizing principle which brings them in line with the kinds of Being and which is what makes their hierarchy preeminently ontological. In our speculative hypothesis concerning the schemas we posit that there are only ten of them, and that each one relates to all the ontological levels of the kinds of Being, manifesting a different organization in each case. In a way we can see the scheamas as a halfway house between the logical and the mathematical because it has characteristics of each. In terms of order the schemas have a finite extent out of an infinite possible series of possible schemas. Each schema has its finite order which is emergent and so in this sense it manifests the kind of uniqueness that the mathematical categories exemplify. But on the other hand the schemas reach into the meta-levels of Being actualizing each meta-level in its own way thus showing that each schema is unique even at the meta-levels of Being. Because it articulates the meta-levels the schemas show a complete and in depth elaboration of the depths of spacetime in which we live unlike mathematical objects which remain on the surface with their organization. If we see the schema as a half-way house between logic and math with some characteristics of each, but with an emphasis on embodiment then we can hardly go wrong in our exploration of the schemas.

In order to understand fully the schemas we need to first understand the fragments or meta-levels of Being that structure the upper levels of the schemas. Therefore, in this chapter we will first explore the fragmentation of Being as a phenomena within the Indo-european worldview. Being is the name of the projection of templates of intelligibility or understanding within our worldview. The meta-levels of Being are the higher order structure that stands behind the schemas in each case. So when we understand the meta-levels of Being and how they elaborate the schemas then we have an excellent picture of the internal articulation of the schemas themselves. This leads us to the exploration of the difference between the system and the meta-system, which is the one odd schema which our worldview had difficulty seeing properly. Therefore in order to ground further discussion the difference between the system, which is used as the example schema in what follows, and the meta-system will be explained. The meta-system is the stumbling block to our opening up the higher level schemas. What follows here is taken from my 2000 INCOSE paper on Meta-systems Engineering with some modifications.

The Fragments of Being

In order to understand this series of meta-levels let us begin very generally and think not just of a *system,* but of any *entity*. Any entity can be designated to have Being. Being is the most general concept we can project on a thing, thereby turning it into an entity[1]. Being is a more general concept than the concept of system. Being covers all the templates of comprehension of things. It is the most general schema that we project on things. Being has traditionally four aspects: Reality, Identity, Presence and Truth. Reality is designated by judgement when we say *X is*. Identity is designated by discrimination when we say *X is X*. Presence is designated by reference when we say *X is here-now* or *This is X*. Truth is designated verification when we say *X is Y*. All of these statements are traditional ways of ascribing Being to things within the Indo-European worldview which is unique among the various historical worldviews in developing the concept of Being.

The study of the most general concept, i.e. Being, and its relation to things is called Ontology. Ontology and Epistemology are the normal constituents of Meta-physics, i.e. the philosophical description of what goes beyond physics. Epistemology tells us what we can know and Ontology talks about whether what we know is really, truly, identically present or not. In this century Continental philosophy has discovered that this most general concept, i.e. Being, is not unified but in fact is fragmented into an assortment of various Kinds of Being. An analysis of these kinds shows that the various kinds of Being are naturally composed of a series of meta-levels along the lines of those we have seen in relation to systems, games and language. Thus it becomes clear that the distillation of the meta-levels of systems and systems-like things is not a specific property of systems, but of all things designated with Being within our worldview. This ontological property of logical layering is specifically rooted in all Indo-European languages. From this we can see that it should in principle be possible to subject all the possible templates of understanding to this same kind of meta-level onto-logical analysis and thus specify their articulation at the various meta-levels of manifestation.

The series of kinds of Being has a specific and determined order that is true for all things.

<u>Being's meta-levels</u>	<u>Bateson's series</u>	<u>Modalities of being-in-the-world</u>	<u>Associated Cognitive abilities</u>
Being^5 meta-level ULTRA Existence	This step into non-Being is ultimately unthinkabl e	empty handedness emptiness or void	cognitive inability
Being^4 meta-level WILD	Learning^4 *Learning to learn to learn to learn*	Out-of_hand	encom-passing
Being^3 meta-level HYPER	Learning^3 *learning to learn to learn*	In-hand	bearing
Being^2 meta-level PROCESS	Learning^2 *learning to learn*	Ready-to-hand	grasping
Being^1 meta-level PURE	Learning^1 *learning as an ideal gloss*	Present-at-hand	pointing
Being^0 meta-level entity	Concrete instances^0 of learning in the world	Orientation toward things	thing

[1] i.e. a thing with ontos.

	the world		

Table 1: Levels of Being

Bateson, in Steps to the Ecology of the Mind, gives an excellent example of stepping through the series of meta-levels in his analysis of the meta-levels of learning. This may be done by starting with anything in the world. Heidegger tells us what the modalities of our being-in-the-world are in relation to the various meta-levels of Being. Merleau-Ponty points out some of the cognitive abilities in relation to things that exemplify these modalities. His view may be augmented by those of Levinas[2] to help fill out this column. Some of these concepts have been filled in by the author to complete the schema[3]. What we can see from Bateson's account of the meta-levels of learning is that when we start from concrete instances of learning and attempt to define learning, what then appears is a fairly static abstract gloss that serves as a definition of a cognitive capability in humans, animals and perhaps in machines. This abstract gloss is what appears at the level of Pure Being. Learning is considered as something that may be pointed out in the world which is present-at-hand, i.e. available to us in the world.

When we go up a level and attempt to understand how we *learn to learn*, this is where the rules or constraints on learning are discovered. Various constraints need different learning strategies to overcome or to maneuver around them. Learning to learn is more than merely something we point out as a cognitive capability. It is something that we grasp in doing it. We relate to it in a fashion which is ready-to-hand, i.e. it is something we use directly to move toward the goal of present-at-hand learning. Learning to learn is like technology, it is an assorted means to an end. This meta-level is called Process Being. *Learning to learn* tells us more about the essence of learning, i.e. the constraints on learning that must be negotiated in order to learn how to learn.

When we move up to the next higher meta-level which is *learning to learn to learn*, things begin to become difficult to think about. It becomes more and more difficult to describe what is meant and to hold onto the concepts at this level. This level is called Hyper Being[4]. At this level we are relating to things via bearing and our modality of being-in-the-world is called the in-hand. It is called the in-hand because at this meta-level things transform into other things in our hands. This level defines the meta-constraints that determine the genetic unfolding of the thing which gives the thing its properties. Thus, this level defines the genetic unfolding of *learning to learn* within the world. This unfolding is something we bear and over which we have little real control. This, for instance, is described by Kuhn[5] in terms of paradigm changes in science. Scientific progress is made by continually expanding our horizon of ways of learning to learn from nature. But one has very little choice in the paradigm changes that occur because they are a social phenomena. One may accept or deny a paradigm, but little else.

Finally, at the last meta-level of learning, i.e. *learning to learn to learn to learn*, one loses control completely. This is seen as a total

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[2] Levinas, Emmanuel. Otherwise than Being : or, Beyond essence. Translated by Alphonso Lingis. Hague ; Boston : M.; Hingham, MA : Distributors for the U.S. and Canada, Kluwer Boston, 1981.

[3] Specifically the idea of the In-hand and Out-of-hand modalities that continue the series started by Heidegger of present-at-hand and ready-to-hand. Also the idea of Encompassing as the highest cognitive level to augment the idea of pointing and grasping developed by Merleau-Ponty and bearing contributed by Levinas.

[4] This name is taken from what Merleau-Ponty in The Visible and the Invisible calls the hyper dialectic between Heidegger's *Process Being*, i.e. Being mixed with time, and Sartre's *Nothingness*. See Merleau-Ponty, Maurice, The Visible and the Invisible; followed by working notes., Edited by Claude Lefort. Translated by Alphonso Lingis. Evanston [Ill.] Northwestern University Press, 1968.

[5] Kuhn, Thomas S.. The Structure of Scientific Revolutions. [Chicago] University of Chicago Press 1962

encompassing by the phenomena where everything is out-of-hand, i.e. out of control[6]. At this level there is no conceptual room to maneuver. Bateson calls it tantamount to personal enlightenment. This is because the constraints that determine the genetic unfolding change so that a different species of a thing is created with a different series of unfoldings. Learning[4] is complete because a constant transformation of the meta-essence of learning is continually changing. This is thought of as something only the "gods" could bear[7]. For human beings it would be tantamount to being subjected to a regime of permanent overwhelming fundamental change. When we get glimpses of this depth of change we call it a genuine emergent[8] event that restructures our world.

From this summary of the levels of Being, as applied to Bateson's levels of learning, we can see that we move from the thing[0] itself in the world, to a gloss[1] of that thing at the first meta-level. At the second meta-level we find that the essence[2] of the thing appears as the rule-like constraints that determine the use of the ideal gloss of the instances. At the third meta-level, we find the meta-constraints that determine the meta-essence[3] properties of the things that underlay the expression of rules, which is how everything within the same category is constrained. Normally this refers to the genetic unfolding of the species of the thing. At the fourth meta-level, we find exceptions[4] to the rules and meta-rules that defy analysis.

Let us take the example of geometry. In geometry we have a series of n-dimensional spaces that are discovered by mathematicians in spite of the fact, we can only experience directly three, or four if you consider time a dimension. The series of n-dimensional spaces are nested in a way that has wonderful coherence and integrity. Points, lines, surfaces and dimensional forms are reused over and over again to produce higher dimensional figures. This nesting of higher and higher dimensional forms can be likened to the concept of the micro-system, meso-system, macro-system, super-system, mega-system etc. At each level there is greater and greater demand for integrity and coherence within the lower level systems which is necessary for the higher level system to work as a higher level ontic system rather than a mere aggregate. However, if instead we go in the orthogonal direction of thinking about meta-systems, then we find very different objects. For instance, given various mathematical figures[0] we might find an n-dimensional space, if we move to the meta-level we find the abstraction[1] of the discipline of geometry. But when we go to the next meta-level we find within geometry the process[2] of producing theorems by proofs and other activities that generate theorems about geometric mathematical objects. If we move up to the next meta-level, then we have the axioms[3] that all our geometry is based upon. Finally if we move up to the highest attainable meta-level of Being, we find exceptions[4] and contradictions. For instance, we really do not know about the essence of geometrical things unless we understand the process of producing proofs. In education geometry is composed of a series of static geometrical forms that we learn about in our classes on geometry. But to become geometers we must learn to do proofs. Learning to do proofs means mastering various techniques for learning about geometrical objects. When we understand proofs within the known realm of geometry then we can begin to question the axioms and postulates that define the domain of geometry. At this level we see that geometry had undergone paradigm shifts when it was discovered that the parallel lines postulate could not be proved. Geometers produced alternative geometries by allowing parallel lines to cross. It was discovered that

[6] Kelly, Kevin, Out of Control : the new biology of machines, social systems, and the economic world Reading, Mass. : Addison-Wesley, 1995

[7] In Greek myth the gods are continually changing their form. However, when human beings in myth transform as Daphne does, for instance. It is usually permanent.

[8] Mead, George Herbert, The Philosophy of the Present. Chicago, London, Open Court publishing Co., 1932.

there was a trace point of indecision[9] in the axiomatic basis of geometry itself. This point of indecision causes a process by which we learn how to learn to learn, i.e. a paradigm shift is generated within the field itself. This causes us to understand more deeply the axioms of geometry. These axioms are the meta-constraints that determine the properties of objects within the geometrical realm. They make possible the unfolding of geometrical proofs that effect the products of the proofs themselves. We define the objects of points, lines and surfaces and their properties and then take them for granted as part of our axiomatic platform. It is possible that there are exceptions or contradictions that may exist within an axiomatic system. These exceptions or contradictions exemplify the highest meta-level of Being. In geometry a contradiction might be generated by maintaining that parallel lines both cross and do not cross. We attempt to avoid such contradictions at all costs because they cause the whole discipline to collapse into chaos. An example of an exception is the dimensionlessness of a point. Everything in geometry has dimension except the point. The dimensionlessness of the point is very difficult to understand, but it is nevertheless assumed as an exception or contradiction within geometry that allows the geometrical formal system to work[10].

[9] See Derrida, Jacques. Of Grammatology Translated by Gayatri Chakravorty Spivak. Baltimore : Johns Hopkins University Press, 1976. Derrida calls these trace points “hinges” we can think of them as hinges between different possibilities.

[10] Another example of an exception is the Mobius band in which a surface only has one side or the Kleinian bottle in which the inside and outside surfaces are the same. Such anomalies challenge our intuitions about geometrical objects and teach us much in the process. For instance, the mobius strip and Kleinian bottle may be seen as lessons in the meaning of non-duality. Non-duality is a property of all holonomic systems. See Rosen, Steven M.. Science, Paradox, and the Moebius Principle : the evolution of a "transcultural" approach to wholeness Albany : State University of New York Press, c1994

Ontic and Ontological Hierarchies

We have explored the various meta-levels of Being in order to show that this is a completely different horizon than that of the various scales of systems. We have seen that when we move in this direction we determine the essence (constraints) of the system and meta-essence (meta-constraints) of the properties of the things within the system that determine the forms that appear within the scale horizon. At the highest meta-level, exceptions in this lattice of constraints are identified, like Godellian statements for which no determination can be made as to whether they are inside or outside the formal system. Now, we will attempt to show how this onto-logical series applies to the definition of a system. This can be done by defining the horizon of scales as the ontic hierarchy. This means that it relates to the things that are designated to have Being without logical differentiation. Orthogonal to this hierarchy is another hierarchy of our ways of understanding the things in the world. We will call this the onto-logical hierarchy. It is composed of the fundamental comprehensible types of things we find. This hierarchy has the following levels:

Pure *Deterministic* *Continuous*	*Process* *Probablistic* *Stochastic*	*Hyper* *Possiblistic* *Fuzzy*	*Wild* *Propensity* *Chaotic*
pluriverse	Over-determination	Coherence	incoherence
kosmos	mapping	Transform-ations	blanks
world	Showing and hiding across horizon	Projection	opacity
domain	filtering	Assumptions	blind-spots
meta-system	dualities	Resources	catastrophes
system	rules	Properties	exceptions
form	Proof of theorems	Axioms	anomalies

	theorems		
pattern	categorization	Spectra	singularities
monad	isolation	cross-over	mutations
facet	distinguishing	Integrity	flaws

Table 2: Ontological Hierarchy

Notice that what appears in this hierarchy are templates for an understanding of things. A system is one of those ways of understanding, but only one among several. Systems, as Rescher has shown[11], are based on intuitions about things that come from dealing with organisms in our environment. When considered very broadly, systems have many of the properties of organisms. Here we define a system as *a social gestalt*. This is to say it is a figure-ground relation seen by a group of people, or degenerately by a single individual. The *sine quo non* of such social gestalts are traditionally other groups of animals, or degenerately single organisms, or further degenerately plants, or at the limit of degeneration physical formations. We project the "system" template of understanding onto the ontic hierarchy. We may alternatively project other templates, or schema, of the onto-logical hierarchy onto the ontic hierarchy. For different phenomena, various onto-logical hierarchy templates may be appropriate. It is a matter of aesthetics or personal preference as to which templates of understanding are projected on which phenomena[12]. Much of the confusion in science occurs because different researchers project different onto-logical templates of understanding onto the same phenomena. The ontological hierarchy as a whole gives us a good measure of our progress in formulating a systems theory and in producing a systems engineering discipline based on such a theory. The standard for systems theory in our time is the *formal structural system* which covers the layers of the ontological hierarchy from system down to pattern. A form is an element in a formalism. We construct formalisms like geometry or logic and do proofs in these disciplines. A weaker standard of comprehension is an explanation which we give when we cannot do proofs. This standard operates at the level of pattern and is called structuralism[13]. It allows us to traverse discontinuities in forms or deal with time. The weakest standard of comprehension is the description of the system. We only give descriptions when we cannot explain or prove. We combine these three different standards of comprehension and call this the scientific approach to phenomena. A good generalized example of a formal structural system is George Klir's Architecture of Systems Problem Solving[14]. Science does not deal very well with any of the onto-logical levels from the meta-system upward or below the level of the monad. However some of these ontological levels are necessary for us to understand what science itself is. For instance, every system that science studies exists in some field defined by the meta-system. We mount our campaign to understand that system by creating a discipline which studies that class of phenomena. That discipline operates in a world shared by other disciplines. All those disciplines are gathered together in the university which contains all accepted disciplines. But beyond the university there may be many quasi-disciplines or proto-disciplines that are not accepted but which exist in the general economy of all possible disciplines including magical or other non-scientific approaches to things. On the other hand the monad is the lowest element of

[11] Rescher, Nicholas. Cognitive Systematization : a systems-theoretic approach to a coherentist theory of knowledge, N.J. : Rowman and Littlefield, 1979.

[12] Systems Engineering is a discipline whose members have a predilection for projecting the "system" cognitive template on things. A more mature discipline will recognize that this is merely one of many different fundamental types of comprehensional templates that are tools we might use to understand things.

[13] There are other kinds of pattern, namely value, sign and process. Process here means discontinuities in time while Structure means discontinuities in some plenum like space.

[14] Klir, George J., Architecture of Systems Problem Solving. New York : Plenum Press, c1985.

content in a pattern. Monads are the existent that the patterns are made of which structuralism finds to be the categorizable contents of form. Facets are the ways that these monads appear to each other in different contexts. The monad is projected by science as the non-reducible level that all other ontic scale levels are reduced to. We projected qualities such as earth, air, fire and water to be atomic until Democritus realized that it was possible that there were quantal atoms. We projected these ideal quantal atoms as the lowest level of reality until we discovered fundamental particles. Eventually we gave up this level for quarks which are never seen in isolation. Eventually we may give up quarks for something even more basic. Projecting the ultimate stratum level zero of substance[15] is part of the game of science which attempts to reduce everything to that level. But in doing so Science reveals the levels of ontic emergence that segments the ontic hierarchy into various recognizable levels of phenomena which have different characteristics and different kinds of relations. Each of these ontic levels is the underdetermining basis of the next higher level. "Supervenance" is the technical term in Analytical Philosophy for the mapping down of a higher level ontic configuration onto a lower level ontic configuration. Each mapping down is partially determined by the lower level and partially non-determined. To the extent that it is not determined there is room to maneuver and room for new non-reducible properties and relations to appear which exemplify emergent phenomena.

Systems Engineering focuses on the emergent aspects that appear at any particular ontic level, however we discern it. It is interesting that systems are assemblies of physical components with specific properties and actions. These components have both functional and agent shadows. As we build up the ontic hierarchy by assembling components, we only arrive at the next higher ontic emergent level when the functional hierarchy and the agent hierarchy meet the assembly hierarchy at the same point. We normally think of function as a single kind of thing that subsumes and supports the intentions of the users of the system. Agency on the other hand relates to the various autonomous actors that work together to perform the functions. The separation of distributed agency and the gatheredness of the intention supporting uniformity of function form a spectra along a single dimension orthogonal to the dimension of physical assembly. The Agency shadows of the component is the basis for what is called the physical architecture while the Function shadows of the physical assembly is the basis for what is known as the functional architecture. When the two shadow architectures that appear within the general economy overflows, the restricted economy of the components that inhabit space and time merge at some ontic level of assembly. Then we have an emergent property appear. If some aspect of the assembly breaks, then we de-emerge[16] from this point of the articulation of emergence. The unity of the functionality of the system fragments and the agency may become uncoordinated. If there are multiple kinds of emergence that occur, then there is really a kind of function related to each kind of emergent characteristic that finds itself integrated at some level of the systems articulation.[17]

In general, given any phenomena that is considered as a system, i.e. a social gestalt, which means a gestalt for some group of

[15] Johansson, Ingvar. Ontological Investigations : an inquiry into the categories of nature, man, and society London ; New York : Routledge, 1989.

[16] This idea of de-emergence originates with Bob Cummings.

[17] This explanation owes much to David Poole of Altair Systems (dpoole@altaira.com) who has developed a state machine method for defining satellite and booster information systems architecture for use in ground systems.

people[18], then we move up to the meta-systemic level. At that level we are breaking apart that system into its constituent elements and, thus, deconstructing it so that its emergent properties disappear and the field within which those elements swim appears instead. That field sees the sub-systems as gestalts on the ur-ground of the meta-system. Any specific thing can be thought of in relation to the various meta-levels of Being. But if we take each of the templates of comprehension (cognitive schemas) up that series of steps, we will get very different results as seen in the table above. For the system which is like a language-game we will find the rules at the level of Process. Beyond that we will find the meta-rules that determine the properties of the things that are allowed within the system. Beyond that we find the exceptions and contradictions that are the violations of the property constraints and game rules.

When we explore the onto-logical meta-levels of the various templates of understanding we find some very interesting differences between the various meta-levels. Looking at the Formal Structural System as a whole we see at meta-level[2] rules, theorems and categories. At meta-level[3] we see properties, axioms and spectra. At meta-level[4] we see exceptions, anomalies and singularities. If we look carefully at these three levels we see the nesting of the levels fairly clearly. Notice that as one moves to higher meta-levels of the system, one finds rules and then properties of things within the system, and then exceptions. But when we look at forms, then there are proofs of theorems and then axioms and then anomalies. The forms are shapes of things with properties. As we advance up the meta-levels of system we approach something that feeds into our understanding of form. Similarly, when we look at pattern, then we move from categorization of contents, to spectra of qualities, then to singularities. Axioms concern the minimal elements from which the forms are built up. Those minimal elements can be categorized according to qualitative criteria as a way of approaching the actual spectra that lie below the categorizations. When we look at monads then we move from isolation, then to cross-over then to mutation. Isolation allows us to see the minimal discernable quanta of the phenomena that makes up the spectra. When we try to determine this exactly, it normally leads to a recognition of a bleeding over into other minimal discernables called cross over or tunneling between isolatable elements. The cross-over or bleeding out of minimal discernables causes us to look at how we distinguish one thing from another and thus calls into question the integrity of our minimal discernables. Cornelius Castoriadis talks about Magma[19] as the non-determinable proto-order of things beyond our projections of order. The lowest bound of the onto-logical hierarchy of templates of understanding is the ontic magma beyond all our discriminations. Deleuze and Guattari[20] talk about the rhizome of interconnections that produces a labyrinth of distinctions and produces monadic discriminations which, taken together, are impossible to organize completely. Facets and Monads are projected beyond experience to explain the fact that we comprehend

[18] Here we ground "systems theory" and thereby "systems engineering" in a kind of social phenomenology ala Alfred Schutz and Aron Gurwitsch. Schutz considers the implications of phenomenology for sociology and Gurwitsch update's Husserl's work to add the awareness of gestalts beyond forms. A combination of the two gives us a feel for what a social phenomenology of systems should be like. See Gurwitsch, Aron. Field of Consciousness. Pittsburgh, Duquesne University Press, 1964. See also Schutz, Alfred, The Phenomenology of the Social World., Translated by George Walsh and Frederick Lehnert. [Evanston, Ill.] Northwestern University Press, 1967

[19] Castoriadis, Cornelius, The Imaginary Institution of Society. Cambridge, Mass. : MIT Press, 1987. See also World in Fragments : writings on politics, society, psychoanalysis, and the imagination edited and translated by David Ames Curtis. Stanford, Calif. : Stanford University Press, 1997.

[20] Deleuze, Gilles and , Félix Guattari. A Thousand Plateaus : capitalism and schizophrenia. Translation and foreword by Brian Massumi. Minneapolis : University of Minnesota Press, c1987.

determinate things within the buzzing confusion of our experience. All the things that do not fit into our projections are pushed out into Wild Being at every threshold of comprehension. It is out of Wild Being that the things that change our view of the world arise. Emergent events move through each of the levels of Being on their way into our world. They many percolate up through any of the templates of understanding. A genuinely emergent event passes through all four meta-levels[21]. Events that do not involve all four levels of Being are called artificial because they do not fully reprogram our organization of the world at some level of understanding.

A similar nesting can be seen occurring at the upper thresholds of understanding. Systems can only exist if they have the necessary resources. Resources are the meta-level beyond the duality or complementarity of meta-systems that is the meta-level of the meta-system itself. The meta-system is normally a set of integrated complementarities of complementarities that defines the environment or ecosystem that the system finds itself within and inhabits. Meta-systems cannot be fully dominated by domains but their filtering of systems is based on higher level assumptions. Domains attempt to construct a restricted economy with a unified ideal viewpoint on the phenomena with which they are concerned. Domains attempt to tighten up the filtering done by the meta-system on its constituent systems by increasing rigor. Filtering is done by the production of theories that connect phenomena in ways that are coherent for the domain. Theories are ways of looking at the phenomena which is based on implicit and explicit assumptions. The Domain is an incarnation of the general projection of the worldview on a specific set of phenomena. This projection is a reification of the showing and hiding of the world. The world establishes the horizons across which the phenomena manifest. Moving from one horizon to another is a fundamental transformation at the level of Kosmos. The kosmos is a mapping exercise that takes us beyond our direct experience and attempts to be all inclusive. These maps attempt to give global coherence to all phenomena of a certain kind. These coherences arise from the over-determinations of phenomena in the general economy that cannot be dominated completely by the kosmos and thus is called the pluriverse because it is constructed of multiple intersecting universes along the lines that David Deutsch suggests in The Fabric of Reality[22]. The highest level of understanding bumps into the incredible variety of things that exists within the universe and not one grand unified scheme can account for all the variety even if it could account for the general laws of nature that underlay the arena in which the variety interacts.

It is important for Systems Engineering as a discipline to realize that the "system" is not the only schema or template of understanding that we might apply to the emergent ontic hierarchy. The "system" fits into the "formal structural system" and this has a dual in the "world domain meta-system". These two dual templates apply to experience and are augmented by two pairs of other templates that are projected beyond experience in order to make sense of experience. Kosmos attempts to unify all the phenomena of the world through maps, and what it fails to map falls off our model of the earth into the pluriverse which is a catchall for all we do not understand about the universe. Monads attempt to supply the ultimate level of reduction at whatever ontic level that it is projected onto, whether it is organisms, atoms, fundamental particles, quarks, sub-quarks, etc… The facet governs everything that falls outside the monad's capability of reduction. Within experience there are six thresholds of comprehension[23], at least notionally. In other words this is only a

[21] See The Structure of Theoretical Systems in Relation to Emergence. London School of Economics, University of London, Dissertation, 1982 by the author.

[22] Deutsch, David, The Fabric of Reality : the science of parallel universes-- and its implications New York : Allen Lane, c1997.

[23] From world down to pattern, because kosmos, pluriverse and monad, facet lie outside experience, i.e. are a priori.

model of the thresholds taken from the current literature of Science in the broad sense which includes hard and soft sciences. There are endless variations of these various thresholds in the literature. But for our purposes we can focus on these six experiential thresholds by which we can comprehend the phenomena we see "out there" in the realm of the ontic emergent hierarchy. The "formal structural system" (notice that these are mentioned in the order of their power of explanation of phenomena) is well understood[24]. What is not well understood is the inverse dual of the formal structural system that appears as the combination of the *domain world meta-system*. Notice that Systems Engineering is attempting at this point in time to establish itself as a discipline with a specific domain. The domain is a filter and the meta-system is the field which underlies this filter, while the world is a showing and hiding structure based on horizons. When we consider the environmental impact of our work on systems, then we are dealing with the meta-systemic field. What we have not yet taken on is the project of World Engineering. World Engineering would have to look at the interactions and side-effects of all possible systems that appear on the horizons of the world. World Engineering is still the stuff of science fiction[25]. If we were to take on that task then there are many things that we would have to consider within the auspices of our discipline that are not considered now. We have not taken ownership of the interspace between the systems we build. World Engineering would consider the relation between the various systems of whatever scale and would take into consideration the interaction of these systems.

Systems and Meta-systems

At this point in the history of the development of our discipline, systems engineering, we tend to focus on *systems* because there has been a good formal structural systemic basis developed by science in the last few hundred years. Systems are descriptive of any phenomena seen as a social gestalt[26]. Systems have broad applicability because they can be applied to any phenomena that is construed as a social gestalt. Thus it is an extremely malleable template of comprehension. It is also highly structured due to the fact that it consists of rules and properties at its meta-level. Proofs and categorizations have greater explanatory power but rules have greater structuring power through the modeling of constraints at both the Process Being *essence* and Hyper Being *meta-essence* levels. Axioms are arbitrary and have limited extent so that proofs have extremely narrow scope compared with structures or systems. Categorizations are also arbitrary and though they have broader extent than proofs, their extent is still extremely limited comparatively. Spectra appear to be grounded in phenomena but properties formulate the qualitative content of the phenomena so that they can be understood and incorporated into our systems as variables. Thus, in general, although the explanatory levels of systems are weak, they give us quite a bit of organizational leverage. That is why we tend to focus on this level when we turn to engineering projects and away from doing science. That is when we leave discovery work and begin building and construction.

We get a fairly high leverage when thinking about things in terms of systems and this compensates for their lack of explanatory power. It seems that there is a tradeoff between explanatory power and structuring at the meta-levels of Being. This is why we do not call our discipline Forms Engineering or Patterns Engineering. But what we fail to appreciate in many instances, is that there is something to be gained by looking at the discipline and meta-systemic levels as well. This essay suggests going one step further than usual by addressing

[24] Wilden, Anthony. System and Structure: essays in communication and exchange. London, Tavistock Publications, 1972.

[25] See Dyson on terraforming the planets.

[26] Understanding the schema system as a "social gestalt" implies social construction and the social invention of systemic phenomena, which implies that systems are not objective characteristics of the phenomena but that they are projected onto the ontic substrate of the phenomena by social groups.

the meta-systems level which, as it turns out, is complementary to the systems level. Meta-systems are environments, ecosystems, situations, milieu or contexts. We see them when we deconstruct the super-system and allow its subsystems to be seen within the internal environment of the super-system. The meta-system indicates the field within which the system arises and within which it interacts with other systems. Meta-systems are inherently complementary and thus not unified in the way that systems are unified. Meta-systems always contain duals, they supply the resources within the arena that the systems need to operate in order to function and interact. They provide the communication between systems within that arena. A good analogy is the operating environment within which applications run in computers, so called "operating systems," which are really meta-systems. Formally, the meta-system is to the system as the universal Turing machine is to the Turing machine. It is an environment that runs Turing machines that it reads from tape and adjudicates between them providing them resources as necessary. Meta-systems engineering is the natural complement to systems engineering. Systems engineering is concerned with the unified product that is to be built. Meta-systems theory is concerned with the environment that this product will go into and its side-effects in that environment[27]. It also considers each level of the ontic hierarchy to be a deconstructed super-system, which when taken apart, gives us a meta-systemic environment for the sub-systems to arise within and interact with each other. Thus, meta-systems engineering is what holds sway as the product is being developed. The meta-system describes the design landscape of all possible product designs and how the selected designs arise and interact within the development process. Processes live inside of meta-systems which produce systemic products. The complementarity between process and product is similar to the complementarity of the system and meta-system. The complementaity between quality and quantity are similar. Product quality is improved by measuring the process that develops that product. Whenever you find complementarities it is a sign of a meta-system. For instance, the complementarity between reading and writing of data in the Turing machine and in computer systems, is generally a sign of an interaction with that machine's environment. Environment related operations are always complementary.

Due to this complementarity between systems and meta-systems, we cannot have a systems engineering discipline without a complementary meta-systems engineering discipline. And it turns out that this is exactly the discipline we need in our time, because it is the side-effects of systems in the environment that is the fundamental problem facing our discipline. We design systems but ignore the meta-systemic implications of those systems and sometimes that leads to unintended consequences. Meta-systems, though, are not just ecosystems but also relate internally to our systems design and to the design process. Thus each supersystem, when de-emerged, turns into a meta-system for the sub-system components. It is this phenomena that leads us to consider the combination of systems and meta-systems holonomic. This is to say that together they describe what Arthur Koestler called Holons[28]. Holons are things like organs in the body that are parts from the perspective of things above them and wholes from the perspective of things below them in the ontic hierarchy. Systems, when decomposed, give us meta-systemic fields which spawn sub-systems and so on down the ontic hierarchy. In other words the ontic hierarchy is constructed out of the action of transforming from system to meta-system or vice versa. The power of the complementarity between system and meta-systemic views is that it generates the ontic hierarchy that encompasses everything that we ascribe to Being within our worldview.

Meta-systems engineering does not look at

[27] See "Industrial Ecology and Systems Engineering – a perfect match?" O.A. Asbjornsen INCOSE 1999 page 35.

[28] Koestler, Arthur, Janus : a summing up. New York : Random House, c1978.

building things, but examines taking them apart. It is deconstructionist[29] in the postmodern sense. In fact, one interpretation of Postmodernism[30] is the realization that there is a general meta-systemic economy that operates outside of the historically sanctioned restricted economy of ideas, values, significance etc[31]. One of the things this postmodern viewpoint takes apart is "systems engineering" itself. When we look at systems engineering as a discipline we see that it is composed of a core related to systems theory and a periphery that is made up of many specialties that come from the various domains in which systems engineering is applied and these are integrated into the various kinds of systems we build. The sine quo non of our approach to building things is the integration of emergent effects from multiple disciplines. Thus, the set of possible domains from which we draw can be seen as the meta-system to the system we are attempting to build. Systems engineering itself is a field with many sub-disciplines making up a rich fabric of concerns. The meta-system is what mediates between the domain of systems engineering and its various sub-domains. What has hardly been imagined yet is that systems engineering encompasses all the various fields of human endeavor by which we attempt to project the template of understanding that allows us to see systems in the world. The complementary template is that of the meta-system which sees the underlying proto-gestalts of gestalts on the ur-field beneath the figure ground relations that make up the system. These two templates together allow us to define holonomics which is the study of holons and holarchies of holons. This gives rise to what is sometimes called *whole systems design*[32] which is a subfield of systems engineering that is concerned with the production of holonic systems, i.e. systems that fit into the whole and are whole themselves. The ideal of such systems are what George Leonard[33] calls *Holoidal* systems which are systems that have attributes like a hologram in which each part functions based on an image of the whole system. Holoidal systems are the opposite of aggregate systems which are blind to the wholes that they are a part of. Whole systems design is directed at understanding holoidal systems and building them such that the world is seen as nested wholes each of which is holoidal in relation to the upper level wholes of this different kind of ontic hierarchy. In this kind of hierarchy we have increased the level of coherence demanded from the meta-system coherence of fields to the coherence of domain filters or to the level of the coherence of the world itself where the horizons are seen to be coherent. As we do this the nature of the ontic hierarchy changes. Systems Engineering puts together forms so that they create coherent gestalts. Meta-systems engineering wants the sets of gestalts to be coherent. Domain engineering wants those gestalts to be coherent with respect to a selected filter of phenomena, sometimes called a paradigm. World engineering wants all the horizons upon which phenomena appear to be coherent within a worldview. What starts out as a bland composition slowly takes the form of a hologram as we go up the levels of the ontological hierarchy and imagine a different kind of engineering at each level. A Kosmic engineering, if that were possible, would ask for all the worldviews to be coherent within the universe.

Equally as we move down the ontological ladder we encounter greater and greater degrees of de-coherence where monads, the minimal discernable elements, are the ultimate

[29] Derrida, Jacques. Of Grammatology. Translated by Gayatri Chakravorty Spivak. Baltimore : Johns Hopkins University Press, 1976.

[30] Plotnitsky, Arkady. Complementarity : anti-epistemology after Bohr and Derrida. Durham : Duke University Press, 1994. See also Plotnitsky, Arkady. In the Shadow of Hegel : complementarity, history, and the unconscious. Gainesville : University Press of Florida, c1993.

[31] Bataille, Georges, The Accursed Share : an essay on general economy. Translated by Robert Hurley. New York : Zone Books, 1988-1991

[32] See Whole Systems Design Association at http://www.earthcorps.com/wsda/

[33] Leonard, George Burr, The Silent Pulse : a search for the perfect rhythm that exists in each of us New York : Dutton, c1978.

conceivable fragments of existence. Systems Engineering attempts to increase coherence one notch from the level of forms in the world because its structuring in the meta-levels of Being provides a big jump in terms of effective coherence. But this coherence carries with it the emergent properties that are realized by the systemic whole. It is necessary to allow a complementary de-emergence to occur which will give coherence to the set of gestalts rather than merely to the gestalt itself.

Moving from separation to gatheredness we go to even higher level notches on the coherence scale by applying the ontological hierarchy to the ontic hierarchy step by step. This takes us more and more deeply into *whole systems design*[34] as a branch of Systems Engineering. Systems Engineering should stress its foundations in Systems Theory. Unfortunately these foundations are lost to most of the "systems engineering" community because they never studied systems theory. It is strange to think that the theory of systems is not required for professionals to practice systems engineering. This is like saying that electrical engineers do not need to know the theory of electrical circuits in order to design them. Hopefully, eventually systems engineering will rediscover its roots in academic General System Theory. Then the discipline will no longer feel adrift with no scientific foundations. General Systems Theory is the meta-science of all science that treats systems in general in a scientific manner. General Systems Theory is to Particular Sciences as Mathematical Category theory is to the various Mathematical Categories, like sets, groups, lattices etc., that are the objects of various branches of mathematics. But Systems Engineering should also recognize its sister discipline, Meta-systems Engineering, which should be based on a General Meta-systems Theory that should complement general systems theory. Unfortunately, this discipline does not exist at the moment, unless we consider the study of ecosystems[35] an example of such a study restricted to how biological organisms interact within their environment. However, we can still pay attention to meta-systems within our practice, by considering the implications of what we are doing for the relevant environment and by considering the design field itself out of which our solution arises. We can also think about how the de-emergent fields within which sub-systems operate as part of the super-system.

Conclusion

In this paper we have breached the question of General Schemas Theory and have constructed a framework that relates it to Logic and Mathesis, then we explained the various different kinds of Being and how the various schemas are articulated by the meta-levels of Being. Then the difference between the system and the meta-system, as opposed to the super-system, was explained. Three of the sections of this chapter were taken from an INCOSE 2000 paper called Meta-systems Engineering. The point has been to paint in broad brush strokes the articulation of General Schemas Theory as a discipline by relating it to well developed disciplines such as logic and mathesis, but also by relating it to the meta-levels of Being which makes this schematic hierarchy ontological.

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[34] Whole Systems Design homepage is at http://www.arashi.com/wsd/

[35] Pickett, Steward T., Jurek Kolasa, and Clive G. Jones, Ecological Understanding. San Diego : Academic Press, c1994.