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Emergence and Complexity in relation to General Schemas Theory

A point of discussion within the Systems Science Enabler Technical Working Group of INCOSE

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Abstract

This paper discusses how Emergence and Complexity are orthogonal concepts in the context of the distinction between System and Meta-system schemas.

Emergence and Complexity

In order to understand the question of the relationship between complexity and emergence we must consider a topic that I think is more fundamental, which I call the distinction between Systems and Meta-systems. I mentioned this at the recent INCOSE 2007 workshop on Complexity Theory in the Systems Science Enabler Group. From my point of view every System or Meta-system is a projection onto the existence of a schema in the Kantian sense. But these projections are not merely subjective; they are intersubjectively founded. Thus the schemas are not configured singularly in the mind of the solitary Systems Engineer, they can be varied by using a consensus of our imagination, which is what makes innovative design possible.

Once it is realized that there are whole sets of schemas such as facet, monad, pattern, form, system, meta-system, domain, world, kosmos, and pluriverse, then we can see that there is a general phenomenon of projection from different organizational templates that make phenomena intelligible. General Schemas Theory considers these sets of schemas as a whole and attempts to understand their relationships to each other. It turns out that Emergent Engineering, i.e. engineering in relation to all the schemas that produce emergent effects, is a much broader discipline than just Systems Engineering per se.

But, the important distinction that we must make is between the System and the Meta-system, which is essentially a distinction between emergence and de-emergence. We hear a lot about emergence, but little about de-emergence in discussions of the popularizations of this concept. The work of John Holland has drawn attention to this conept. I would like to add that if we think of BOTH emergence and de-emergence then I think the concept becomes more comprehensible. I would like to emphasize the difference between the perceptual terms that I will refer to as the gestalt and the proto-gestalt as a way of talking about this difference. What we are talking about here is a blind spot in our culture and intellectual tradition, and that is why it is so difficult to come to terms with the difference between Emergence and Supervenience. So let me try to explain.

I assume that the System is like a gestalt. The first of these is *con*ceptual and the second is *per*ceptual, but it is basically the same cognitive phenomena. These have an inverse or opposite that is not a self-dual. I call this the Meta-system or the proto-gestalt. If you do not realize that there is an inverse of the System, or gestalt, then you will become completely lost because there is no grounding contrast for you to tie your concept of the System to. In our culture there is a kind of nihilism because we call everything a System. In order to change that we need to understand that something else does exist on the same plane of abstraction which is like a System, which is its inverse, the Meta-system. In Mathematical Category Theory you first describe the category of the System and then you ‘reverse the arrows’ to get the idea of the Meta-system. It is the complementarity of the System and Meta-system that is the key idea here. But this relates to Emergence because the gestalt of the System has a complement which is the de-emergence of the Meta-system. The next step is to elaborate on the qualities of the Meta-system and the best example of that is G. Bataille's Accursed Share. A good explanation also appears in A. Plotnitsky's Complementarity. For other examples please refer to my papers, especially "Reflexive Autopoietic Dissipative Special Systems Theory" or "Meta-systems Engineering."

Now *Complexity is a concept that is orthogonal to the distinction between System and Meta-system*. This distinction denotes that Complexity in itself is independent of Emergence or De-emergence. Emergence and De-emergence can happen in simple objects. We see that in the table of the elements and the emergent differences between the elements of nature. The great unexplained question is: When you add a neutron, or a proton, or an electron to an element why do you get a qualitative difference in the substance? All we have to do is to think of the table of elements and we know that complexity is not related to emergence or de-emergence in any fundamental way. So that means that complexity does not precipitate emergence. There is no necessary correlation between the simplicity/complexity and the emergence/de-emergence distinction. However the two can be conflated or combined in our imagination or our thinking. I believe that the independence of these concepts is fundamental to the discussion we are undertaking here.

This means that both Systems and Meta-systems, and the other schemas, can be simple, complicated, complex, chaotic etc[1]. Although both schemas have a range of intricacy, there is a difference between the schemas that are characterized as projections and the noumenal object that is projected upon. Noumena is a Kantian term for the nature of an object that is *beyond* our projections onto the object. Schematization is our projection of a space-time envelope onto the object. Different schemas have different inherent organizations. Schemas are not just neutral but carry the baggage of a particular kind of organization that can get in the way of seeing the object’s own intrinsic organization. Our problem is that our access to the noumena beneath the projections is mediated by the projections of our templates of understanding of space-time organization. So the first thing we need to work on is how the range of intricacy affects our projections,

[1] Palmer, K.D., “The Failure of Systems Engineering as an approach toward Complex Adaptive Systems in our major Customer’s Eyes: Analysis of the Capstone Concept for Joint Operations and its relation to Meta-systems Theory” CSER 2008

and then we have to focus on the relationship of the projections to the noumena that are being projected upon. And this is precisely the work of science. But science unfortunately takes the schemas as being objective or as a given, i.e. as ‘out there’ in space-time rather than as the organization *of* space-time. Because of this there is general confusion within science about the nature of the schemas and their organization, they are mistaken for the organization of the phenomena being projected upon. However, science, despite this confusion, eventually tends to sort out what comes from the noumena beyond the phenomena, as well as our projections of order that do not relate to the noumena. And when that is sorted out, we call it a scientific discovery.

Then there is also the point concerning the difference between the complicated and the complex. If I were to distinguish those terms I would say that it is a difference in synergy. That which is complicated is an intricacy which is merely synthetic rather than synergistic. Therefore, I think that Complexity Theory should have some connection to B. Fuller's concept of Synergetics. Something that is synergetic reuses parts for different purposes. So something that is complex has an over-determination that is operative in its articulation, while something that is complicated is merely a synthetic assemblage that is underdetermined. The reason for the confusion of complexity and emergence is that it appears that the difference of characteristics that comes from synergy is similar to the difference of characteristics that comes from emergence. In fact I believe that there is a difference that *makes* a difference between these two differences (ala Bateson). In other words, synergetic phenomena do not necessarily have to be emergent. Some synergetic phenomena can be de-emergent. For instance, a Meta-system can be complicated or complex depending upon the characteristics of the phenomena in question.

So, for example, the various flows within the ocean become very complicated at some fractal resolution. But whether there is any synergy in those flows is another question. For instance, the Gulf Stream flow is part of a global conveyor belt of energy that causes a globally distributed flow that stretches between the Pacific and the Atlantic traversing the Indian Ocean. That flow takes 1000 years to complete its cycle, and it is what keeps Europe from succumbing to a perpetual Ice Age. If that global oceanic energy flow stopped it would throw us back into the erratic atmospheric conditions that existed prior to 10,000 years ago. That flow has created a synergy between the atmosphere and the oceans on a global scale and has produced a balance that has made it possible for human civilization to develop agriculture. Global warming is affecting that flow and could stop it. We are at risk of reducing that synergy back to the synthesis of complications that gave us the erratic weather prior to the last 10,000 years that characterized our planet during most of its entire geological history. But the global oceans and the atmosphere are two Meta-systems that make up an even larger Meta-system of the global earth environment. This is the Gaia Meta-system that supports myriad human and nonhuman entities including environmental systems. But is that whole flow an emergent system? It only would be if we separated that one global flow from all the other flows in the entire oceanic and atmospheric Meta-system. Systems must have a boundary. Wrapping the system around the earth and putting it on a sphere so that it has no boundary makes it a Meta-system instead of a System. We see the flow as an emergent system on the background of the global air/ocean Meta-system if we bind it. If we do not bind it then it is just a part of the entire Meta-system that has a synergetic complexity rather than synthetic complication. *What this example shows is that it is possible to convert a difference in intricacy into a difference which is emergent by viewing it in a different way, i.e. by supplying a boundary*. And that shows that both the idea of emergence and the idea of intricacy are simply ways of looking at things and not necessarily part of the noumena itself. Now we can bring them together in our consideration of the phenomena, but to do that we must not become confused. We must keep their difference clear in our minds so that we don't think that just because something is complex it must also be emergent, or that just because something is simple it may not be emergent.

If we make various distinctions that are conceptually different, and if we conflate them in ways that are incorrect, then we only confuse ourselves. That is why a Philosophy of Systems Engineering is necessary. We think of ourselves as practical people solving real world problems who do not need philosophy. But, in fact, there is always an implicit philosophy behind everything we do or say which can haunt us and cause unforeseeable problems if we do not acknowledge its usefulness. Philosophy helps us to clarify our concepts so that we do not find ourselves tangled in our own words when we try to describe what we should are doing, or how things should be done, or more generally how we should approach the work of Systems Engineering in a theoretical manner. If you are going to consider the foundations of our discipline, then philosophy, especially the modern philosophy of science, cannot be avoided. It is the job of the Philosophy of Engineering and Science to distinguish intricacy from emergence in meaningful ways so that we can know what we are saying when we discuss these subjects with each other.

Why is this of interest to Systems Engineers? It is because we use the schemas as our guide for our designs. We don't refer to its noumenal nature and its organization except as a constraint on our designs. Rather, the designs themselves are based on the schemas that we project upon nature, and when we make our designs based on the schemas we create an artificial world, different from what nature would have created. The artificiality of the world we design and produce in our systems engineering products is based on the structure of the schemas. And so, when we are involved in the process of design, it is important to us as Systems Engineers to understand this ordering of our creations that springs from us as the natural human organization of space-time embodiments.

My recent research work has been to try to discover if there are foundations for the practice of Systems Engineering and I think I have found them in the Schemas. There is Systems Theory but we need something more than that for the foundation of our discipline. We need General Schemas Theory, which is the analogue of Systems Theory at the next higher level of abstraction that comprehends all the schemas. We need to understand the strange properties of the schemas and how they relate to mathesis and especially dimensionality. Then, on the basis of such a General Theory of Schemas we can understand Emergent Engineering, which is our practice of producing emergent artifacts at various schematic levels, sometimes at several levels simultaneously. Many times the artifacts that we produce are more than synthetically complicated but are in fact synergistically complex, although that is unrelated to whether they are emergent systems or de-emergent meta-systems.

But for us to have an effective Emergent Engineering program we must first develop an understanding of Emergent Science. I believe that Emergent Science is orthogonal to Complexity Theory, Chaos Theory, and other elaborations of emergence/de-emergence that we find in various phenomena. All of this is an open horizon for future research. But we cannot explore this open horizon unless we understand some very fundamental distinctions, i.e. a paradigm (Kuhn) or episteme (Foucault) or ontos (Heidegger), which will enable our research to proceed into this new horizon. And that is what I have been striving for in my research. We need to think beyond Systems Engineering, Systems Theory, and Chaos Theory, and Complexity Theory as specialties. We must think in a broadly transdisciplinary way about the fundamental issues that effect our discipline and this kind of thinking will fundamentally transform the discipline. I am hoping that we can eventually agree upon distinctions such as these and that it this will lead us to a type of thinking that is beyond the box of Systems Engineering as it is now defined and beyond Complexity Theory as it is now defined.

We need to recognize that our discipline for calls us to think about questions that have not really been asked concerning the relationships between some very fundamental distinctions. If we discover that certain distinctions are orthogonal to each other then we are making headway. It means that we can develop our concept of Systems Engineering or Meta-systems Engineering separately from the present articulation in terms concerning the question of intricacy or dynamics. This will make our job of finding the foundations of our discipline much easier to the degree that these concepts are independent. In addition to this it will increase our understanding because we can deploy these separate and independent concepts together to understand the phenomena we are describing. Orthogonality between concepts gives us the needed parallax for a better understanding of the phenomena we are seeking to comprehend. Orthogonality of concepts gives us leverage to understand things if we realize that we should not conflate concepts that are distinct. The realization that there is such an orthogonality means that we need to think more deeply than the mere superficial deployment that these concepts currently receive in popularizations of the discipline as well as in some scientific presentations. Sometimes we need to think about things at the philosophical level in order to clarify what we mean by the various concepts we use. And to do that we must be aware of what philosophy can offer us as a of resource for these types of discussions. *This type of philosophical enquiry is what Plato called the Dialectic*.

References

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Biography

Kent Palmer, Ph.D. is a Systems Theorist and Systems Engineer. His Systems Theory research website is at http://archonic.net. His new Ph.D. research website in the foundations of Systems Engineering is at http://holonomic.net. He is a student at the University of South Australia System Engineering and Evaluation Center (SEEC).