

Exploring Intelligent Enterprise System Limitations

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Abstract. In this paper we will consider the implications of Meta-systems Engineering for Intelligent Enterprises. We may think of this as the dark side of intelligent enterprise systems. Our essay is a search for light at the end of this tunnel by employing the theory of Special Systems and the Emergent Meta-system. This work brings together advanced theories in order to redefine the nature of the Intelligent Enterprise and Enterprise in general.

Limitations to the Intelligent Enterprise Systems

The Dark Side. The theme of this INCOSE 2007 Conference, “Intelligent Enterprises,” gives the impression that developing systems into more intelligent, elegant, and efficient tools is a necessary and positive endeavour; a task that seems like something that would bring about unalloyed good. But here we will consider the darker side of Intelligent Enterprises. It is the side that goes *beyond* what the System schema can describe. This entails putting Intelligent Enterprises into the context of Meta-systems Engineering rather than just Systems Engineering. An earlier example of this was given at the INCOSE 2001 Conference under the title “Anti-Terror Meta-systems Engineering.” It is the intention of this paper to show how Meta-systems are the complement of Systems and how Meta-systems Engineering should complement our pursuit of Systems Engineering. Fundamentally this means looking at the limits and the context of Intelligent Enterprises and perhaps considering some of the darker aspects of the concept.

Context. A meta-system is the dual of a system. In this case “meta” is taken to mean ‘beyond,’ meaning that the meta-system is everything beyond the boundary of the current system. But strangely, ‘systems’ contain meta-systems as well. This is because the sub-systems of a system also have meta-systems that exist between the *system’s* outer boundary *as well as* the outer boundary of all of its *sub-systems*. Thus, the meta-system is in some sense the context, milieu, eco-system, environment, and/or media of the system. When we think of Intelligent Enterprises then we need to understand their contexts and avoid the pitfalls of merely considering them in isolation. This leads to the idea of having a market for intelligence and, moreover, a market in general as being the context for the intelligent enterprise. This also brings out the fact that the Intelligent Enterprise may be viewed not only as a system, but also as a meta-system for the intelligent organizational units it contains. Thus, the meta-system appears on two fronts in relation to the intelligent enterprise. It appears both on the inside and the outside.

General Economy. In his book, [The Accursed Share](#), George Bataille uses the term “General

Economy” for what we have referred to as the meta-system. He characterizes systems as “Restricted Economies”. Restricted Economies are rational while General Economies are irrational. General Economies include not only the market, which may be ruled by chaotic dynamics, but also the gray and black markets and all other activities of human beings that are irrational including insanity, crime, and war. George Bataille surveyed strange quasi-economic behaviour from different cultures and pointed out that these anomalous quasi-economic activities have a certain structure that they share in which they exhibit extreme or exotic behaviour that goes beyond rational economies. Looking at these general behaviours across disparate cultures is the goal of the study of the General Economy. Part of the General Economy is the existence of blackholes and miracles and singularities, as well as a dispersal of continuities and discontinuities across the field of the General Economy. Restricted Economies can be likened to ships sailing on the stormy seas of the General Economy. Restricted Economies have to work to remain viable within chaotic and runaway processes as well as disruptive and destructive conditions within the General Economy.

Limitations. If the Intelligent Enterprise is conceived as a Restricted Economy it falls prey to the limitations imposed by the General Economy that is placed on every Restricted Economy. In some sense we are talking about a transformation of the Corporation as it is redefined by the Intelligent Enterprise by using Systems Engineering principles. We are not necessarily talking about the transformation of the corporation as such, rather we are talking about making the corporation more intelligent in the use of its resources, in its internal processing of information and materials, and in its interaction with the markets that it deals with. We normally conceive of the Corporation and its Organization as one system and ignore the fact that it is both within a general economy *and* has a general economy within it. This means that just as there are rough seas outside the corporation, there may also be turbulent seas within the corporation that organizational units have to deal with. We see this particularly in the environment of mergers and corporate takeovers as well as at times when there are great market pressures that externally provoke internal transformations in the structure and functions of corporations as they can try to remain viable. Corporations are limited both inwardly and outwardly with meta-systems over which they may not have much control. For the intelligent enterprise, the goal is to meet these inner and outer challenges in such a way that corporations not only remain viable but also make the most efficacious use of resources, opportunities, processes, and interaction with the environment. Normal corporations might be seen as blind to their own situation, or as being suspended helplessly in a general economy. We would hope that the Intelligent Enterprise is aware of its position as both a system and meta-system. The limitations on the Intelligent Enterprise mentioned in the title of this paper are recognized to the extent that they recognize their inward and outward environments as General Economies or meta-systems.

The need for Meta-systems Theory. We have systems theory. And we have the discipline of Systems Engineering which hopefully will eventually realize that its foundations are in Systems Theory. But what we do not have is a Meta-systems Theory that is the complement of Systems Theory. And we don't have a Meta-systems Engineering to complement our Systems Engineering. Thus Meta-systems Theory and Engineering are the horizon for the future development of our discipline. Unfortunately, it is not recognized that this sort of theoretical and practical development is necessary for our discipline. The author's paper on “Meta-systems Engineering” appeared in the proceedings of the INCOSE 2000 conference. A year later it was

expanded by adding these examples: “Anti-Terror Meta-systems Engineering” and “Vajra Logic and Mathematical Meta-Models for Meta-Systems Engineering.” However, there has been as yet little further development on the theory and further research is needed. The author has seen only one other paper in which a researcher came to a similar conclusion, one that rendered meta-systems an important problem. Therefore, I am writing this case study in order to prompt the Systems Engineering Research community to consider this question more deeply.

Sources of Meta-systems Theory. One of the problems that we are encountering is that Systems Engineering is a new discipline that functions in a vacuum with respect to other disciplines. There are many advances in various fields that have not filtered into the Systems Engineering community as yet. The work on General Economies has been part of the development of Structuralism, and Post-structural movements in Europe. The leading exponent of this way of looking at things (one that recognizes that there is something beyond rational and restricted economies) is Bataille, although Jean Baudrillard has also contributed in his work For a Critique of the Political Economy of the Sign. Arkady Plotnitsky has written Complmentarities where he shows the confluence of the work of Bohr, Derrida and Bataille as they describe different aspects of the General Economy. There is also the post-structural philosophy of Gilles Deleuze which has important things to say about the nature of ‘economies of difference’. These are all sources that Systems Engineers with technical backgrounds are unlikely to run into even if they were doing active research in this area. But if such research was cognizant of the theory of General Economies, it would lead to a completely different understanding of the problems encountered when ‘relating systems to their environments’, i.e. meta-systems. Such a change in our way of thinking can be characterized as something deeper than a paradigm shift which only deals with our assumptions, instead our new way of thinking could be characterized as an episteme change, i.e. a change in our categories of knowledge. As soon as we begin to think beyond systems and acknowledge the existence of meta-systems, then we must re-categorize everything to account for the place of the new phenomena in our view of how things relate to each other within our universe of discourse.

My own work consists of taking these structural and post-structural insights and placing them in the context of mathematics, complex systems theory and advanced General Systems theory so that their importance can be understood by Systems Theorists and Systems Engineering researchers and practitioners. A comparable effort is that of Manuel Delanda in his Intensive Science and Virtual Philosophy where he attempts to explain some of the insights of Deleuze in terms of Complex Systems Theory and Mathematics. From this theoretical work there have been many advances that give greater credulity and solidity to the theory of meta-systems. This new research poses questions concerning the nature of all schemas that human beings use to organize their understanding of the spacetime embodiments of things and serves to ground Meta-systems and Systems Theory by giving it a broader context.

Theory of Corporations, Enterprises and Intelligent Enterprises. It is clear that we first need a theory for Corporations, Enterprises and Intelligent Enterprises. And if we think of them only as Systems to which we might apply the discipline of Systems Engineering, then we are accepting a huge limitation on our ability to understand this phenomena and realign it with our human goals. This is particularly important in a time of globalization when there is an

international proliferation of corporations which span the globe and participate in global markets. The globe itself is a limit in as much as it describes the entire market and the world that embodies the possibility of that market. Global economies are synonymous with General Economies because they are 'all encompassing' and thus must represent rational as well as irrational activities. For instance, Global Terror networks are now a part of that General Economy and their target is not only governments but also corporations. These networks of terror cells operate on the paradoxical logic of the General Economy, which is illustrated in the Potlatch ritual of the Indians of the Northwest, *where the destruction of the most goods leads to the greatest prestige*. Part of the General Economy is the production of transcendental values by destruction, especially involving self-destruction. This irrational behaviour is a reality in the global closed system and it poses a danger not just to governments but also to corporations, enterprises, and even virtual enterprises. Another example is hacking computer networks. This destructive activity has its own sub-culture where it produces transcendental value by breaching or disrupting networks controlled by educational, governmental, military or corporate entities. When a network stretches throughout the world then it is difficult to exert control over activities such as spam, worms, viruses, etc.

Parasitic use of the infrastructure within the meta-system view. One way to think about the Terrorist Network is to consider it as the *intelligent enterprise gone over to the dark side*. The brilliance of the terrorists was that they realized that they could use the American Infrastructure against itself to cause mass destruction. This was a fundamental paradigm shift because we were used to thinking about systems, not meta-systems. The terrorists were the first organization to think about the possibilities of using the infrastructure of a country to attack that country, and its citizens (including its corporate citizens). It does not matter how intelligent an enterprise is if it does not often recognize the difference between systems and meta-systems and recognize that threats can come from its own meta-system. Intelligence is not just processing more information faster and better, it must also commit to understanding how these paradigm shifts and episteme changes have occurred in the environment and how they need to be responded to proactively. This raises the bar on what we consider the intelligence of the Enterprise. The Enterprise that is truly intelligent must recognize emergent events, i.e. events that change the way we conceive of our world and our situation in that world. *Terrorist cells and networks do not have to have any system, they are completely parasitic and all they have to do is to find a way to use the host's meta-system against them, like a virus*. This in itself is a realization that we are trying to emulate when we set up virtual enterprises in which we leverage off of various systems' infrastructures to create a new entity. In virtual enterprises we are trying to combine various infrastructural components from various corporate systems to produce something new and different with its own viability and internal organizational logic (i.e. Business Model). In both cases there is a parasitic use of infrastructures for either destroying or building something new. The key shift that has been made is to actively use the meta-system either for or against the systems that it houses. The intelligence of enterprises, that do not recognize emergent events such as the sudden use of infrastructures for purposes other than that for which they are built, is suspect. This is a fundamental limitation on the intelligence of enterprises that we must recognize and attempt to overcome. That means we must understand emergent events, and we must, in this particular case, have a theory of meta-systems to add to our theory of systems, *and eventually we must engage in Meta-systems Engineering, not just traditional Systems Engineering*.

What is the Intelligent Enterprise

A Meta-systems View. Once we have switched to the Meta-system view of the Intelligent Enterprise we get a very different view of what the Intelligent Enterprise might be. In this section we will view Special Systems Theory and Emergent Meta-systems Theory from a meta-system perspective to produce a different and new definition of the Intelligent Enterprise.

Intelligent Enterprises (IE) are normally thought of as a systematic organization of people pursuing joint goals, perhaps as a corporation, which has some additional efficacy compared to a normal enterprise. All Enterprises are subject to organizational entropy which prevents or hinders achievements of joint goals. The Intelligent Enterprise somehow lessens that organizational entropy by applying the human capital of the organization more effectively. It is assumed that if we consider an organization or corporation from a systems engineering perspective then we are more likely achieve additional efficacy as we apply Systems Engineering Methods.

Our first point is that Systems Engineering Methods are ungrounded. They are mostly ad hoc traditional approaches that, to some extent, have proven effective but have now become partially codified. However, there is no reason to believe that the application of Systems Engineering methods to human organizations will be as effective as it has been in the technological realm. And it is particularly worrying that Systems Engineering would treat the human beings within an organization in the same manner that it does technology. Human beings have many qualities that are very different from these technological apparatuses and this needs to be taken into account. There are disciplines that Systems Engineers normally do not have knowledge of that deal with organizations of people from a human perspective (such as Organizational Psychology and Organizational Sociology). So the idea that Systems Engineers have some special knowledge of how to deal with human organizations based on their varied success with technological systems is in some doubt. Sociology and psychology are human centred disciplines that have been in existence for quite some time compared with Systems Engineering (which is a nascent discipline within academia) and these disciplines have methods directly related to dealing with human beings. Systems Engineering has no grounded methods related specifically to dealing with human beings and their organization. So the whole idea that Systems Engineering can contribute to Intelligent Enterprises beyond their technological infrastructure seems very doubtful. Psychology and sociology must be considered as having viable and applicable theories and techniques that will be useful in developing Intelligent Enterprises.

The Joint Operations Capstone Document issued by the U.S. military highlights the problems that Systems Engineering has in dealing with 'real world' human organizations. Our major customer, the U.S. Military, has now decided against using Systems Engineering as a means of organizing themselves for war and in war. This point is developed in a paper by the author called "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." This point should cause us to pause and take a hard look at our discipline from the viewpoint of our major customer in order to understand the limitations of our discipline.

However, if we adopt a broader view in which we consider the foundations of Systems Engineering then perhaps there *is* a basis for a contribution from a broader discipline that will include Meta-systems Engineering. Organizational Psychology and Sociology also suffer from the same problems that Systems Engineering suffers from, such as obscuring and ignoring the meta-system and concentrating too much on the system. Organizational and Cognitive Psychology as well as Social Psychology and Organisational Sociology all treat their subjects as systems but rarely if ever look at their subjects in relation to meta-systems. Now is the time to introduce the meta-system approach to the Intelligent Enterprise. However, for this to happen Systems Engineering must transform itself from a ‘one schema discipline’ into a ‘multi-schema discipline’ that includes meta-systems in its panoply of approaches. We might call this new discipline which approaches its subject in terms of multi-schemas: Emergent Engineering. If Systems Engineering Theorists (I think there are some) were to consider deeply the limits of Systems Theory in grounding Systems Engineering as a practical discipline, I think they would discover that there is no complementary Meta-systems Theory and Meta-systems Engineering practice guidelines for the current theory and practice of the discipline. Therefore, our argument about IEs is a general argument, one that posits that SE does not know enough about Human Beings and Human Organizations for its own good and the good of others for whom technological systems are being built, and furthermore Systems Engineers do not know enough about the grounds of their own discipline and methods to be helpful to others or themselves. I argue that the ‘systems focus’ of Systems Engineering has been detrimental to not only the discipline, but to society and the environment in general. The focus on engineering systems while ignoring their environments, contexts, and unintended consequences has led to many current problems and will lead to greater problems in the future if we do not transform our discipline radically. However, to transform the discipline we need a secure foundation for our method and an understanding of our discipline to make that possible. Environmental Impact assessments of systems are not enough. Rather, from the very beginning we need methods that build meta-system concerns into the design of our systems. And ‘system of systems’ approaches are not enough to solve this problem, because they merely apply the system schema to a higher level of abstraction and still ignore the problems of the meta-system.

So, we propose that Emergent Engineering take a new look at the Intelligent Enterprise based on Meta-systems Theory, as well as Systems Theory. Now, it turns out that because of advances in Meta-systems Theory there is quite a bit to say about Intelligent Enterprises based on this new theory. In this paper we will hit a few highlights and attempt to give a brief summary of how Intelligent Enterprises may look from the vantage point of Special Systems Theory and Emergent Meta-systems Theory (which are extensions of the theory of the relationship between Systems and Meta-systems). However, in order to understand this, one must be ready for not only a paradigm shift, but for an episteme shift such as described by Foucault as a deeper shift that occurs when our very categories of knowledge change.

Once we understand that Systems and Meta-systems are inverse duals of each other, and that anything can be viewed from the vantage point of either schema, then we begin to see the fine detail of the interspace between Systems and Meta-systems. It turns out that we must think of Systems and Meta-systems as thresholds of organization in relation to scale and that there are some sub-thresholds between the system and meta-system that have unusual properties. These sub-thresholds of organization are called Special Systems because of their unique properties. It

turns out that between the System and Meta-system Schemas there are three sub-thresholds of schematization called Dissipative Ordering, Autopoietic Symbiotic, and Reflexive Social Special Systems. These sub-thresholds are partially systems and partially meta-systems in different mixtures. Each has its own special ordering, and an ordering quite different from that of either the System or the Meta-system. The normal way of explaining the difference between these different thresholds is to start with the fact that a System is a Gestalt, a whole greater than the sum of its parts, meaning that they are a whole with emergent excess properties. Since a Meta-system is the inverse dual of the System it is then a whole that is less than the sum of its parts. That is to say, *a Meta-system is a whole with holes in it*, like a sponge, except the holes are niches into which systems nest. That difference leaves the possibility that there are wholes exactly equal to the sum of their parts. These three special systems are different kinds of wholes that precisely add up to their parts with no excess nor any lack. An analogy for the Special Systems would be perfect numbers and their kindred amicable and sociable numbers. Perfect numbers are wholes that exactly add up to their parts. Sociable and Amicable numbers are numbers that mutually add up to each others parts, i.e. they add up to their parts with some mediation or delay, but ultimately together they add up to their parts. Once one accepts that such a species of Special System exists, then it is just a matter of finding out its characteristics. Those characteristics are quite unusual and they are relevant to the nature of the Intelligent Enterprise. This is because Special Systems are Ultra-Efficacious, i.e. Ultra-effective and Ultra-efficient in relation to normal systems. This is because they divide exactly into themselves and there is no friction between parts that do not quite fit into the whole (as can happen with Systems or Meta-systems or other schemas). These Ultra-Efficacious Special Systems have characteristics that are similar to those of Life, Consciousness and the Social which are all ultra-efficacious phenomena. In fact, we can equate the Autopoietic Symbiotic Special System with Life, the Dissipative Ordering Special System with Consciousness, and the Reflexive Social Special System with Language and Self-consciousness in the Social. When we start to look at Enterprise in general, we notice right away that it is a social group of conscious living things with cultural and technological apparatuses. The Heart of Enterprise, as Stafford Beer says, is a human group creating variety. What we are hoping to do in Intelligent Enterprise is to improve the efficacy of the functioning of this human group. However, by definition a human group is already founded on the infrastructure of the special systems. So perhaps we might think that the best way to achieve intelligent enterprises is to reinforce and make manifest the fundamental efficacy of the Special Systems that are already at the basis of the Enterprise. Our goal is to try to transform this into an *intelligent* enterprise, i.e. an enterprise that realizes its full capacity for intelligent consciousness, for social organization, and for living life to the fullest.

In other words, our approach in defining intelligent enterprises is to focus on what is revealed when we look more carefully at the difference between systems and meta-systems. When we see that enterprise is founded on the special systems, and that making enterprise better, i.e. more intelligent, we are merely building upon the foundation that is already at the basis of human enterprise. Thus, we would define the Intelligent Enterprise as one that recognizes its own foundation in Special Systems, one that makes the foundation better defined and more effective and more efficient in its operation. This will increase the ultra-efficacy of the enterprise in a way that we will recognize as intelligent as well as adaptive, more fully alive and less reified, and better organized.

This theoretical outlook called Special Systems Theory is explained more fully in “Reflexive Autopoietic Dissipative Special Systems Theory” which is part of a book of essays by the author titled Reflexive Autopoietic Systems Theory.

The Intelligent Enterprise of Systems Engineering

Applying Intelligent Enterprise approaches to Systems Engineering Projects. We must recognize that it is *people* who build technological systems and human organizations. Therefore, as an example to others, it is incumbent on us to affirm the validity of the Intelligent Enterprise by applying it first to ourselves. Unfortunately, we are very far from reaching that goal in most organizations that apply Systems Engineering methods and processes to produce products, whether they are technological products or human products such as organizations (say in re-engineering) or combinations of both. Systems Engineering is still a craft. It has not reached the stage of having scientific foundations for its work. But one of the things we must realize is that it cannot continue to ignore the role that the human sciences, (such as sociology and psychology, and organizational design, as well as other disciplines that deal with the human element) play directly in its work.

We can help by applying Intelligent Enterprise ideas not only to the *product* of our work but also to the *work itself*. This will improve our understanding of that organization and how it *relates* to the products we build as well as the *processes* that we use to build those products. In this we will have the advantage of having a theory that specifically addresses the problems and forms and functions of the organization of Intelligent Enterprises. That theory is, of course, Special Systems Theory and its corollary, Emergent Meta-systems theory. However, that theory has radical implications for how we might organize Intelligent Systems Engineering Enterprises.

Let us consider some of these implications without going too deeply into the theory itself. For one thing an Intelligent Systems Engineering Enterprise (ISEE) would always organize itself as a system with an eye on the meta-system *beyond* its boundary *and* the complementary meta-system *within* its boundary. It would *not* organize itself in terms of hierarchy, but in terms of *conjunction* because Special Systems are modeled on conjunction operators not on hierarchical relations. It would recognize that its dissipative ordering capacity (in relation to its environment) is far from achieving equilibrium in the neg-entropic capacity of a complex adaptive system. Now, because it is very delicate, it might encounter organizational entropy at every impasse that it must navigate. It must realize that its first task is the autopoietic task of self-organization, self-production, and self-maintenance rather than allopoiesis (other organization). And it must realize that it is producing a reflexive social environment which must be maintained to make the team work and operate effectively. Traditional Organizational styles which are hierarchical, sovereign, and individualistic tend to block the production of organizations that facilitate the special systems functioning. It is very interesting that once we understand the nature of special systems, which Plato was trying to tell us about in his organization of imaginary cities in his dialogues, we then can see how our own organizations specifically block or hinder those types of organization within our society. Here Foucault’s analysis of power is very pertinent. Power relations tend to destroy the delicate structure of Special Systems type organizations. However, it appears in our ideal of teamwork where we attempt to put aside some of these power relations in order to produce the product more efficiently and effectively. This is ensconced in our way of doing business under the name Integrated Product and Process Development (IPPD) Teams. Power relations tend to be contrary to conjunctive organizational structures and corporations are islands of sovereign power within our democratic society. Sovereign power attempts to control the

Accursed Share, i.e. the productive excess in the market, in order to maximize profits. Sovereign power tends to destroy human centered organizational units like neighborhoods, families, or communities that are antithetical to hierarchical power and the centralization of power. Kevin Kelly, in his book Out of Control, describes the interrelationships that are instilled by Complex Adaptive Systems as well as those that are implied in Special Systems Theory (which is a special case of Complex Adaptive Systems).

The view of human relations that is needed is more like that of Deleuze and Guattari in Anti-Oedipus and Thousand Plateaus. That is to say: the individual is de-centered and the emphasis is on partial objects (desiring ‘machines’¹) and the *socius*, i.e. the social fabric in which those partial objects circulate, is said to be rhizomatic rather than hierarchical. It is interesting to note that the theory of Deleuze and Guattari mirrors the relations between the special systems. The conscious practices of partial objects (desiring, avoiding, disseminating, and absorbing ‘machines’) are seen as an embodiment of the dissipative ordering special system. The living individual can be seen as an embodiment of the autopoietic symbiotic special system. The *socius* (as a field) can be seen as the embodiment of the reflexive special system. Once we understand that a very different political philosophy is implied in Special Systems theory (as well as in Intelligent Enterprises) then we need to come to terms with these new decentralized models, models that are so decentralized that they question the sovereignty of the individual and focus on the social glue between human beings that makes their interaction fluid and flexible. We have a long way to go in understanding, less well implementing, such social structures that are truly ultra-efficacious in corporate America. In the meantime we need to try and understand the challenge before us.

Emergent Meta-systems and Intelligent Enterprises

Emergent Meta-systems. Beyond Special Systems Theory there is another more advanced theory that specifies what happens when we combine Special Systems with a Normal System. As a result of the conjunctive nature of Special Systems, you get the image of a Meta-system when a Special System and a Normal System are combined. You can reverse this and say that a special system *in* a meta-system serves to produce the conditions for the spontaneous arising of a normal system as an ordering from nowhere, thus explaining the mechanism of emergent events. If we see Intelligent Enterprises as Emergent Meta-systems, then we can understand how they can spawn new Intelligent Enterprises spontaneously as described by Jane Jacobs in The Economy of Cities. On the other hand, if we understand Intelligent Enterprises as Systems, we can understand how they relate to the meta-system through the mediation of the Special Systems which are embodied by the conscious living human group engaged in the enterprise. Such a group has been described previously by Sartre in Critique of Dialectical Reason as the Fused Group, or by Elias Canetti in Crowds and Power as the Pack. Deleuze and Guattari use the more theoretical name of the *socius*. In Deleuze and Guattari there is a language that describes this new way of looking at human organization. What we can bring to that literature is a Systems and Meta-systems Theoretic way of approaching the subject so that it can be understood and put to use in our technological and human organizational endeavours.

In our organization we can also use these theories to understand the practice of our own discipline and formulate new theories of design that focus on the way that these theories would

¹ The use of the term ‘machine’ here is unfortunate as it means something prior to the differentiation of humans and machines. Thus it has a special sense in the theory. Better to think of these as practices instead.

help us to understand the nature of the design of emergent systems and meta-systems. This is the thrust of my own research into Systems Engineering Foundations which is: How does the Intelligent Designer engage in the enterprise of designing the emergent system or meta-system, or any other schematically organized product?

Challenges to Systems Engineering in order to realize Intelligent Enterprises in its own practice

Challenge One. Systems Engineering must understand its own theoretical basis in Systems Theory. Current Systems Theory is not adequate, even with the addition of Complex Systems Theory, to deal with the reality of producing complex technological systems, less well complex human systems.

Challenge Two. Systems Engineering needs to develop Systems Theory in order to meet its needs and thereby extend it to other schemas besides systems, such as the meta-system schema. Systems Engineering needs to understand the nature of General Economies or Meta-systems and how to deal with them practically.

Challenge Three. Systems Engineering needs to become multi-schematic and transform itself into Emergent Engineering which focuses on producing emergent effects regardless of the schematic active media that is the target of its design and production activities.

Challenge Four. Emergent Engineering needs to understand not only other schemas but also the partial schema thresholds between schemas such as the Special Systems. It needs to learn to theorize and apply those theories to building Reflexive Autopoietic Dissipative Ordering Special Systems, i.e. Holonomic Systems.

Challenge Five. Emergent Engineering needs to understand how the Special Systems and Normal Systems combine to produce the Emergent Meta-system, which is a model of the Special Systems working together.

Challenge Six. Emergent Engineering needs to encompass a better understanding of how the human element plays into the systems and meta-systems it builds. It needs to become more aware of the human sciences such as psychology and sociology and other human sciences that naturally relate to its focus on producing a system that interfaces with the human being as operator, but also as a target or victim of its technological creations.

Challenge Seven. Emergent Engineering needs to apply the knowledge of Special Systems and Emergent Meta-systems to its own projects and its own human organization in its efforts to build technological and human systems.

Challenge Eight. Emergent Engineering needs to apply the knowledge of Systems, Meta-systems, Special Systems, and Emergent Meta-systems to its products, whether they are technological or human systems such as enterprises, corporations, institutions, virtual organizations, and teams. We need to incorporate Intelligent Enterprises in a manner that fosters human potential and growth rather than constraining it.

Challenge Nine. We must understand how Emergent Meta-systems Theory helps us understand our own practice such as the design of Emergent Systems or Meta-systems.

Challenge Ten. We need to influence other Academic Disciplines by bringing this new way of looking at things into the Universe of Discourse so that Emergence Engineering can claim its rightful place as an Emergent New discipline among the other disciplines that are already established in the academic community.

Conclusion

Transforming the Discipline by recognizing its broader foundation in multiple schemas.

This paper has looked at the dark side of Intelligent Enterprises, i.e. at the meta-system view rather than the system view, but perhaps there is a light at the end of this ‘tunnel vision’ that Systems Engineering has had up to this point in its development as a discipline. It is possible that Systems Engineering will transform itself into Emergent Engineering and become a multi-schematic discipline with a secure foundation in the knowledge of the way that the various schemas operate in relation to each other. This will provide an understanding of what our discipline has to contribute as we seek legitimacy within the academic world. New disciplines need to bring something new to the table that is not already part of other disciplines. I am suggesting that Emergent Engineering has what other disciplines do not have, which is a *synoptic* view of the schemas in relation to each other, a *systematic* view of the relations of the schemas and their relationship to each other, a *meta-systematic* view, and of course a *special systems* view. As a new discipline we are not bound to follow the other disciplines in everything that has been done before, such as nurturing an obsession with one particular schema while ignoring all others. Even though we began to operate in that way and ensconced the system schema in the name of our discipline, we can still open up and consider other schemas and their relations to each other.

Develop Advanced Design Theories as a basis for Emergent Engineering. If we were to adopt and develop the theory of the Meta-system, Special Systems, and Emergent Meta-system then we could apply them to both our technological products and our design of human organizations, such as the human organizations that do Systems Engineering.

Realize Intelligent Systems Engineering Enterprise through the practical application of these advanced theories. If we had the advanced theories that would expand Systems Theory and if those were scientifically grounded, then we could apply Intelligent Enterprises to our own Emergent Engineering projects and realize the efficiency that this might produce. But this implies that we would have to stop applying technologizing approaches to humans, and instead, humanize the technology, by humanizing the organizations that are supported by that technology.

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Kent D. Palmer has a Ph.D. in Sociology from the London School of Economics of the University of London. His 1982 Dissertation is titled The Structure of Scientific Theories in relation to Emergence. Since then he has been engaged in a career in Systems and Software Engineering at major Aerospace Companies with a special emphasis on Technology and Process. He is now engaged in a Research Project at the Systems Engineering Evaluation Center (SEEC) at the University of South Australia on the nature of Emergent Design in relation to General Schemas Theory. See <http://holonomic.net>.