Meta-System Engineering Futures

The Advance of the Systems Engineering Discipline through an understanding of Meta-systems theory.

Kent D. Palmer, Ph.D.

P.O. Box 1632
Orange CA 92856 USA
714-633-9508
palmer@exo.com

Version 0.02; 11/06/01; fs00a02.doc

Keywords: Systems Engineering, Systems Theory, Science, Technology, Nihilism, Futurism

A Question Concerning The Future

Where are we going as a discipline?

This is a question that we should all be contemplating from time to time. With the growth of INCOSE and the increased recognition of the importance of Systems Engineering as a discipline we can all feel that progress has been made in the last ten years or so. However, this begs the question as to where Systems Engineering should ultimately be going as a discipline. Here I would like to suggest a path for the discipline in order to elicit discussion of this important question.

The path I would like to suggest is one that recognizes the kinship between Systems Engineering as a practical discipline and Systems Theory as an academic pursuit. I believe that not enough has been made of this connection between these practical and theoretical approaches. Instead we search for our foundation in many other places such as mathematics, formal languages, software engineering, etc. Systems Theory is however I believe the ultimate refuge for those of us who want to understand exactly what a *"system"* is. This over used and under-defined word needs more precise delimitation. For my own part I take the definition of the formal structural system elaborated by George Klir in Architecture of Systems Problem Solving as a point of departure. But this is just a personal prejudice. There are really many different definitions of a system, some say as many as there are systems theorists. However, for the most part these definitions cluster around the same set of features of the groups of things taken together in the world. And in some ways it does not matter which one you pick, as long as you pick one and stick to it, so that others can know what you mean when you use the term -- *system*.

I have suggested in another article on "Meta-Systems Engineering[1]" that there is something beyond Systems Theory that has not yet been clearly defined but which is on the horizon of Systems Engineering because it is on the horizon of Systems Theory. That is what I call meta-systems theory. Meta-systems are the dual of systems. Systems are not self dual but instead have an inverse which we don't talk about very often. But it is obvious that every system has an environment or ecosystem that surrounds it and which it is embedded in. This use of "meta" means *beyond* rather than *above*. The meta-system is what is *beyond the system*, its inverse. There are not many examples of theoretically built meta-systems in the literature because this has been a traditional blindspot of western systems researchers. However, just let me mention one I have found recently that fits the bill. It is what Erik Sandewall calls an Inhabited Dynamical System (IDS) in his book

[1] INCOSE 2000

Features and Fluents[2]. In that book Sandewall wishes to test various AI theories about agents and causation. To do that he constructs a test universe specifically designed to allow him to look at the similarities and differences between various Agent Planning, Knowledge and Action based theories. It is the first case I have ever run into where instead of constructing a theory an author instead constructed an environment in which to test theories. This is a very great advance because it means that Sandewall is thinking at the Meta-systemic theoretical level rather than merely at the level of the theoretical system as such.

In Systems Engineering we know about this because we are creating test environments for the systems we build all the time in order to test them before we place them in the real environment to validate them. So this is a place where Systems Engineering practice is well ahead of Systems Theory. And there is a good chance that there are many such aspects where practice is ahead of theory. But in fact, that is a problem, because if we do not have theories of the structure of meta-systems then we will have a hard time describing, explaining or building them in order to test systems. So here is a place where Systems Theory should learn from Systems Engineering. But there are equally many places where the reverse is true. Systems Theory has no practical side that allows it to generate problems for the academics to solve. But on the other hand Systems Engineering lacks the theoretical foundation that will allow it to ground its practice. It can appropriate Systems Theory but really it needs not just a Systems Theory but also the inverse of that, a Meta-systems Theory. It will take both of these to ground a robust Systems Engineering practice.

Schema Theory and Schema Engineering

But is that enough? Can we stop there? In my earlier paper I answered this question no. Instead I pointed to a whole series of *schemas* that we need in order to design things to fit into the world which include worlds, domains, meta-systems, systems, forms, patterns etc. In fact, what I noted was that what is needed is a *General Schemas Theory* which will allow us to use many different schemas to guide our thought about the kinds of things we attempt to design and build in order to fit into the world. Thus, I believe that we have to go beyond just systems and meta-systems to include more and less detailed schemas that form the context or the content of what we are building. Thus, we might conceive of General Schemas Theory and General Schemas Engineering, where the schemas might be Worlds, Domains, Meta-systems, Systems, Forms or Patterns within the realm of contact experience. Schema Engineering would be the designing and building of artifacts that incorporate multiple levels of schemas within them as we do today, without much of a theoretical foundation for our practice. For instance, there might be a World Design, Domain Design, beyond the Meta-system Design and the System Design and the Formal Design.

There is, of course, a dual to the Schemas too. That dual is made up of things that appear at natural levels of emergence in the world at large untouched by human artifice. In other words Science discovers many emergent layers in the outward world which have their own coherence and self-determined articulation independent of our effort to order or disorder things around us in the cosmos. It is this dual to the schemas that Science pretends to concentrate on and which Systems Science and Systems Engineering use as a basis for further elaboration. Systems Science tries to understand these emergent levels in terms of the *System* schema while Systems Engineering tries to design and build things according to that same schema. But we could on the larger scale attempt to understand things according to the *Meta-system* schema and then try to build meta-systems. Or we could try to understand things according to the *Domain* schema and then try to build domains as we do when we work on Product Lines that

[2] Oxford Science Publications, Clarendon Press, Oxford 1994

are the basis for the production of multiple systems. Or we could try to understand things according to the *World* schema and then try to build worlds as we do in games and virtual reality.

Thus, I am arguing that we expand our horizons not to just the inverse dual of the System, i.e. the Meta-system, but to the whole series of schemas that stand as ways of projecting order onto the emergent levels which Western Science finds in nature. In this expanded horizon Science, General Schemas Theory and Schema Engineering stand together in a three way relationship where Science deals with the anomalies with respect to our theories, General Schema Theory looks at the similarities across disciplines of theoretical constructs, and General Schema Engineering attempts to design and build things based on our understanding of the inner coherence and essential nature of things as captured in our projections of order on the cosmos.

These are a set of mutually reinforcing relations, a kind of reflexive mirroring between the three viewpoints. In other words, Science discovers laws and orders in the cosmos that then are modeled across disciplines with Schemas Science, one part of which is Systems Science. These schemas are used as a basis for designing and building artifacts that fit into the world and by that change it. Science can then study this changed world and discover higher level effects than were visible before the intervention. But on the other hand, Science can only investigate if Engineering builds the tools to do the experiments. Science is dependent on Technology produced by Engineers. Technology is the integration of things discovered by science using the schemas as a basis for ordering based on implementations developed by Engineers. Technology is the center of the reflexive mirroring between Nature as discovered by Science based on an exploration of the anomalies that break our theories, Schemas that integrate the theories *and* designed and built implementations of the theories that are our products from Schemas Engineering.

This brings up a point that we need to pay close attention to, because technology is discovered by some strains of Western philosophy to have a direct connection to Nihilism, the fundamental sickness of our worldview. The connection between Nihilism and Technology is explained very well by Fandozi in his book Nihilism and Technology. The nature of nihilism itself is explained by Stanley Rosen in the book Nihilism. Nihilism is the production of extreme opposites that appear to be in conflict, but ultimately turn out to be the same. We note that Technology seems to be developed most rapidly in War. Technology amplifies forces beyond what we might be able to do unaided. Many say that Technology is neutral, i.e. it is the wielder of the technology that determines if it is used for good or ill. But several philosophers have noted that technology itself at its core is produces nihilism, i.e. the distortion and enervation of meaning in the world. We might think of the dynamic of the reflection in the three way mirror of Nature, Schemas, and Engineered Artifacts as the circulation of Nihilism. Nihilism in many ways can be thought of as the Inverse of vaunted ideal of "*Progess*". Nihilism might be said to appear everywhere genuine progress fails to be made. Genuine progress might be thought of as holistic, i.e. progress not from a limited perspective but overall with respect to the human condition. If we think in this way then understanding the relation between the world, technology and nihilism needs to ultimately become a priority for Scientists, Systems Theorists and Systems Engineers and the same applies to the other schemas.

The three mirrors and the circulation of the reflexive mirroring that we have been discussing is a model of the Western view of the "World" schema. The Western World is composed of the Logos and the Physus as a primary split according to our tradition. This spilt is again based on a deeper spit between Finitude and Infinity. These are the underlying dualisms that structure our worldview in the

Meta-physical era that we are in right now and have been in since Thales and Anaximander. This is also talked about in terms of the mind/matter or theory/practice dualisms. In any event we can see that the realm of the physus is that where science tests its theories, and changes them because of discovering anomalies. Logos is the realm of speech and thought where we build projections. These projections may be infinite as with the schemas that can be applied to almost everything under the sun, or finite in which case we see them as designs such as those that Systems Engineers create. When we look at the relation between Science, Theory and Engineering Practice we are looking at the fundamental model of our world, and at the core of that world is the Technological infrastructure which is producing the dynamics of Nihilism with which we must all deal in our lives. That nihilism turns up for engineers as unforeseen side-effects of the things they build. It turns up for Theorists as a divorce with Practice that sucks the life blood from their work. It shows up for Scientists as the proliferation of scientific results without their integration into over arching ways of understanding the world. Nihilism is the going astray of our projects which sometimes take on a life of their own so that the world seems decentered and out of control, say as in the case of Terrorist attacks that use one part of our technological infrastructure against another to kill and wreak mass destruction. All these are engineered products that are being used to amplify the power of the terrorist to do mass murder and create mayhem. There is bio-engineering that produces anthrax as well as aeronautical engineering that produces planes and civil and structural engineering that produces high buildings. There is the military engineering that helps us to wreak revenge on those we see behind the mischief. Ultimately we have to approach the problem that somehow at the heart of our worldview the combination of Science, Theory and Engineering that produces the technological infrastructure gives off as an unintended side effect nihilism. And if we are not practicing responsible engineering these side-effects can get out of control or even lead to adverse results in the wrong hands that we did not imagine when built each of the systems that taken together are used against us. *Our own creations used against us!* If this is not something that should be the cause some reflection, I don't know what is.

Systems Engineering understood along with Social Sciences and Humanities

This paper does not seek to give a remedy for this situation. But it merely hopes to raise the issue that engineering needs to both integrate itself better with other disciplines, academic disciplines, but also it needs to consider the human and planetary consequences of the artifacts it builds based on science and the theory that allows for the integration of technology. Now part of this expansion of the horizon of Systems Engineering contemplated here is the split between not just the sciences from the humanities, but also more specifically engineering from the humanities. We need to rethink this split which is symptomatic of the dualisms that plague our society and are part of the reason that nihilism is so rampant. Systems Engineers need to gain some perspective on the humanities as those who study the humanities need to gain respect for the Systems Engineer and other Engineers who design and build the world we all inhabit. Both Social Sciences and Humanities are something that Engineers have little appreciation for because they do not have to take very many humanities and social science courses in school. Once that General Education requirement has been met then there is no reason to ever think about it again. But there is a dialogue needed here between the Human Sciences and those who Engineer for Humans. If you have little appreciation for the humanities and social sciences then you are more likely to build systems that dehumanize and tend to reify our world even more, perhaps inadvertently producing alienation and anomie. On the other hand, under the guise of the Study of Science and Technology there is much that is written about our Scientific and Engineering culture that is untrue by those who have no experience in it, but remain isolated in the

regime of Logos, i.e. Academia, having no experience of the Physus, i.e. Industry. Of course, there is that split again in the Logos as we distinguish between Research and Development verses Production. Research and development can take place either on the side of Academia or the side of Industry. In general it is the dualistic spits that bring about the proliferation of Nihilism because all these splits are artificial conflicts that sap meaning from our world. What we need is not engineered humans but humanized engineering. We can only get to that by breaking down these unnatural barriers and erecting bridges in their place.

So ultimately Systems Engineering has to become a kind of World Engineering which understands the interplay and mirroring between Science, Theory and Practice in a way that diffuses the nihilistic effects that inadvertently occur because of our assumptions and presumptions that so easily go awry in the actual world because of our various blindspots. Instead we need to open up the horizons of Systems Engineering and transform it into something different from what it is today by letting other viewpoints and agendas in from outside, like those of Systems Theory, Philosophy of Science and Technology, the Social Sciences *and* the Humanities. This diversity of views and opinions concerning the nature of Systems Engineering can only enrich us.

Thinking in terms of "Systems" rather than the analytic parts that do not add up to ***a whole greater than the sum of the parts*** is a rare skill. The way our recruitment works now we only allow to become systems engineers those who have mastered the details and are suited to that and then from among those we select those who can rise above those details to have a vision of system synthesis. But there are many who study other disciplines outside engineering that may more naturally have the skill to see wholes, but they are eliminated from selection by our educational and hiring practices. For instance, someone who studied biology or music might be better and understanding organic wholeness than those who have learned a traditional engineering curriculum that might tend to get lost in the trees rather than building a picture of the whole forest. A good way to cross fertilize with other disciplines in the social sciences and humanities is to hire these graduates to do Systems Engineering. A good example is the area of Systems Engineering process improvement. This is definitely an area that needs an understanding of psychology, sociology and other soft skills. The process improvement initiative is going to transform systems engineering. It already has if you think of INCOSE as originally a way of avoiding Software Engineering Institute initiatives. It is interesting that INCOSE has organized the Systems Engineers but there is no comparable body for Software Engineering. There is an interesting duality between Systems Engineering and Process Engineering. This is based on the duality between gestalts and flows. If you think of Systems as social gestalts and flows as the duals of gestalts then you realize that Process Engineering is just the dual of Systems Engineering. So why avoid it? Why don't we accept this duality and use it to our advantage. Basically Process Engineering looks at the behaviors of the people that build the products rather than the products themselves with and eye to what might improve the quality of the end product, like reviews.

However, there is a way of looking at this duality in terms of meta-systems. We can imagine that there is a dual of the meta-system as well called the meta-process. Sandewall goes to great length in his book Features and Fluents to define ways of describing these flows and the relation to them of agents who act on those flows based on knowledge and plans. This duality is based on the existence of something I call a proto-gestalt and a proto-flow that appear in our perception of things which we conceptualize as the meta-system and the meta-process. A proto-gestalt is the sequence of our vision as it looks from gestalt to gestalt. The

proto-gestalt has what David Bohm[3] calls an *implicate order*. Similarly a proto-flow is the implicit sequencing of our perception as we move from flow to flow when looking at a river full of various streams. Just as a gestalt is composed as a whole of figure on ground. So to a flow is a foregrounded stream against a reference mark of some sort. You can get a sense of this duality if you look at a rock protruding slightly from a stream and compare that to a rock just below the surface of a stream acting as a reference point for gauging its flow. The shift of the gaze from the gestalt to the proto-gestalt comes from the realization that the field of vision is a plethora of competing possible gestalts. A river on the other hand is a bundle of competing possible fore-grounded streams with the different back-grounded reference points. At both levels there is a duality. There is a duality between gestalt (system) and flow (process) AND a duality between proto-gestalt (meta-system) and proto-flow (meta-process). There is also the higher level inversion duality between the system and meta-system AND between the process and meta-process. This is a set of complementarities of complementarities which is the definition of the "general economy" according to Plotnitsky[4] in comparison with a given "restricted economy." Plotnitsky uses the work of Bohr, Derrida and Bataille to attempt to define for us the nature of the *General Economy* as opposed to the *Restricted Economy*. Basically the General Economy is as Bohr notes with respect to quantum phenomena just a field of complementarities of complementarites with nothing beyond that. The existence of David Bohm's pilot waves behind the phenomena observed is denied. There is nothing to understand beyond the *Uncertainty* of Quantum Mechanics according to Bohr. When we recognize the complementarity of complementaries we have seen all there is to the General Economy. But science wants to construct restricted economies that are determinate. This leads to the complementarity of theories, like Kant's Antinomies, and the complementarity of observations, as in the duality of particle and wave in Quantum Physics.

[3] Wholeness and the Implicate Order

[4] Complementarities, In the Shadow of Hegel.

Understanding Meta-systems and Meta-processes

Most of the projects we undertake and the systems we build are meant to function as restricted economies. We fight to keep them under control in a world that is constantly changing and bringing us up against unexpected and unforeseen events. But we have little understanding of the nature of the general economy that produces blackholes and miracles as well as singularities around which we must navigate in our restricted economies. Would it not be better to study the properties of meta-systems and meta-processes in order to understand them better rather than keeping them in our theoretical blindspot that appears only in the form of the assumptions we attach to our proposals and bids. Both Process Engineers and Systems Engineers need to embrace each other and then grow up to live in the real world which is a general economy where Murphy's law is the rule and the unexpected emergent events are the norm. Things are only going wrong from the view of the restricted economy. The risks are only measured with respect to the original plan. But what we see as risk and unending problems and errors is really the continuously changing general economy that is the environment that encompasses every system and every process. When will we start taking seriously the inherent nature of General Economies with plans and risk management regimes that take into account the need for continuous transformation? Growing up to live in the realm of the Meta-system and the Meta-process and their meta-complementarity is something that expands our horizons to the utmost. It means we must build robust systems and processes that can take radical changes in context and content with the inevitable changes in the meta-system and the meta-process. It means that we must live in a world where we do not blind ourselves to the

relations between gestalts and flows or proto-gestalts and proto-flows. In other words we are more like surfers than the builders of houses in the way we must deal with our environment. These aspects of our experience of things are always together in our perception of our lived world. They should always be together in our conceptualization of our designs of our products and processes. The example of a gestalt we all know from introductory psychology, it is any figure on a ground, in a holistic tension between them that gives a whole greater than the sum of the parts. The flow is more illusive, but it is any flowing stream seen against a reference mark. The reference mark is the dual of the figure and the background of the figure is the brought to the foreground as the stream in the flow. When ever there is a gestalt there is a complementary flow. So for instance when driving on the highway we see the other cars in front of us and around us as gestalts that we look at and glance at occasionally. But the landscape at the side of the road is flowing by. We pick out objects going by and look at them in order to perceive this flow consciously. The cars are all moving together and we are among them. That is why we see them as gestalts. This shows that perception is relativistic. Our point of view is tied to the swarm of cars we are amongst. But we see the landscape as flowing by as soon as we look at the side of the road and follow a single object for a moment or two with our eyes. This whole situation is replicated at the conceptual level as systems and processes. Systems are the relatively static socially *constructed wholes greater than the sum of their parts*. Processes are the relatively dynamic socially constructed *wholes greater than the sub(traction) of their parts*. In processes we are *subtracting*, what? Order! Entropy is constantly draining order out of our processes and that is why they are so hard to maintain. It is also how we experience time. When everything is standing still there is still the flow of time. In other words, we can never get into a situation where the complementarity is violated because there is nothing to flow. There will always at least be the flow of time against which to measure our perceptual gestalts. Time is the enemy of processes at the conceptual level as well. Our achieved ratings against the CMMI model decay over time as we unlearn what we have learned to do even after that learning is institutionalized. Constant reorganization and institutional change wreaks havoc with our processes by which we have conceptualized our work.

A similar thing can be said at the level of the meta-system and the meta-process. Here the situation is more complex and closer to reality. There are many systems and many processes working together. We have many figures on many backgrounds and many reference points against which many foreground streams are measured. We see immediately why we need a model to do process improvement. It is a benchmark, a conceptual reference point against which our many process areas are measured. This was merely a missing complementary to what we were always doing which was relating many systems to each other within a field of complementarities which we might call the *General Economy*. We have always just called it the *Real World* where we have to have software and its inverse, the test suite of inverse software in order to do testing properly. All the complementarities that Systems Engineers are forced to deal with in the real world make up the meta-system. That is where everything goes wrong. Where disorder has to be fought every day in order to make progress. The struggle of systems engineers to produce products that work in the world is against the hidden properties of the meta-system. Considering our own behavior as we engage in this struggle is merely the inverse of the system we are creating. Process Improvement is the necessary corollary of System Improvement, i.e. Quality.

We can go further and say that a meta-system is *a whole less than the sum of its parts*. It is a whole full of holes. It is a set of niches in an ecosystem that is filled by systems to produce a working test suite and a verified product. When we take that system and place it in the world

then we validate that the system fits into the niches in the world. So the complementarity of the holey whole that is less than the sum of its parts, is the *subtraction*. A meta-process is *a whole less than the **sub(traction)** of its parts*. This means that time is again the key thing happening here. There is, in fact, a *double lessening* that appears in the intrinsic nature of the meta-process. When we look around the world at what we can possibly perceive we have the feeling that it is all there before our eyes. The proto-gestalt is some tendency to look at certain kinds of objects in a certain order that takes place unconsciously. But the objects we could single out are all there within the horizon of our vision. But this is not true of the proto-flow. That is hidden in the various rates of flow of time that different people experience or different subsets of our unconscious swarm of egolets. Nietzsche was a great proponent of this view that "I don't think, but *IT* thinks" where the *It* (*ID* in Freud) is a swarm of unconscious bits of will-to-power. At least in nature it has been shown that different species experience time at different rates. Amazingly it has been calculated that all animals have about the same relative number of heartbeats and breaths. Some merely experience the time of their lives faster than others. We also know that children experience time at a slower rate than adults because their metabolisms are sped up compared to those of us that are older. But whether we actually have different rates of experiencing time inwardly with only one flow with a certain *being* focused on at a time is hard to say. However, the proto-flow is something like this kind of segmentation into streams of time. But that is only when everything is sitting still, i.e. what Sandewall calls maximum inertia of the Inhabited Dynamic System. When we are out and about in the world that is changing we see that objects in the world all are developing and evolving at different internal clock rates. We see that all the time and it is essential to our ability to simulate things seen and not-seen that we be able to deal with the implicit differences in clockrate of different streams of events. The *whole less than the sub(traction) of the parts* has to do with the fact that time is not just passing but that it is passing at different clockrates within the relativistic field and perhaps even splitting into various strands of time with various clock rates. What is true perceptually is also true conceptually in terms of meta-processes. That is why there is a difference between the organizational level in the CMMI and the project level, i.e. the difference between maturity level two and level three. Projects have different internal clock rates. There has to be something outside the projects that keep the global clock that they can all sync up to at various times in their lifecycles. This difference is inevitable because of the fact that meta-processes are the dual of meta-systems. One is the conceptual equivalent of the spatial dimension and the other is the conceptual equivalent of the temporal dimension. At the *meta* level, beyond the process or system, there are a plethora of discontinuities that manifest, in space and time or their conceptual equivalents. These discontinuities in the field give us the miracles, blackholes and singularities of the landscape which restricted economies have to negotiate. A similar thing occurs in time which positively allows us to deal with the various clocks of phenomena in the world but from the negative point of view produce fractal, dynamic and sometimes chaotic temporalities that must be dealt with both within the individual and in organizations of society. We deal with that from a process point of view by having organizational processes that override the project level processes. That way we create order where there would be a very complex dynamic that might tend toward chaos.

Onward to Special Systems

Once we understand the nature of systems and meta-systems and their manifestation in both perception and conceptually, and the same can be said for the complementary pair of processes and meta-processes, then we are ready to ask about the Special Systems which have the feature that they are *wholes **exactly equal** to the sum of their parts*. Now Special Systems

need to be a subject of their own paper. But you can immediately see by the definition proffered above that it is possible to be either a whole equal to the sum of the parts or a whole equal to a sub(traction) of the parts. This allows us to define two types of Special Systems. The first is the Dissipative Special System so named for the work on Dissipative Structures by Pirgogine. The second is the Reflexive Special System so named for the work of the sociologists Barry Sandywell and John O'Malley. The fact that we can either add or subtract parts to get a whole that is exactly equal to those parts means is extraordinary. But here we must note that the addition and subtraction themselves are transformed into *conjunction* and *disjunction*. The plus sign in a complex number "ax+bi" does not mean addition any longer, nor its opposite "ax-bi" subtraction. But even more extraordinary is the possibility that there is a third kind of Special System that balances between this addition and subtraction which we might just call "*injunction*". That kind of Special System is called Autopoietic named after the theory of Maturana and Varella concerning self-producing systems. The ultimate adventure for Systems Engineers and Process Engineers once they finally begin to accepting the necessity of the existence of each other, is to understand how within the duality between systems/meta-systems or processes/meta-processes are other rare forms of systems that until recently were not even dreamed of or their possibility uncovered. Bringing these Special Systems with their unique properties into the realm of Systems Engineering Practice will be a great challenge. In order to do that we need to first lay the foundations of what might be called Emergent Meta-systems Engineering. That entails fully assimilating the complementarity of complementarites between process and system and between meta and infra levels of organization. Then, we need to explore the special systems that approach perfection by holding a dynamic balance between addition and subtraction (really conjunction and disjunction) that amount to a compensation around the fixed point of the perfect balance where the whole equals exactly the sum of the parts without any deferring as in the perfect numbers that is an analogy for the autopoietic special system. The amicable and the sociable numbers are an image of what is meant by the dissipative and reflexive special systems that show dynamic balance. These Special Systems are defined mathematically by the Hyper-complex algebras. The complex algebra is founded on *conjunction*. As this algebra looses properties at the various levels we can say that the "+" also changes its properties into a kind of *injunction* at the quaternion level with the loss of the commutative property and *disjunction* at the octonion level with the loss of the associative property. There are anomalous physical phenomena that exemplify their unique structures discovered by modern physics like solitons, super-conductivity, and the recently demonstrated Bose-Einstein condensates. They are seen at work in the phenomena of life, consciousness, and the social. They have the strange properties of ultra-efficacy due to a combination of ultra-efficiency and ultra-effectiveness based on their negative entropy. There are many strange aspects of these Special Systems that are waiting to be discovered and used to build new kinds of artifacts with strange and wonderful emergent properties once Systems Engineering matures and widens its vision beyond a blind acceptance of the innate goodness of technology, the infallibility of Science, the indellibleness of Systems Theories, and the lack of awareness to its own assumptions and blindspots of Systems Engineering itself. Will Systems Engineering ever take responsibility for more than the systems it produces? Why not the environment those systems operate in and all the side-effects of short sighted designs? Why not the planet? Special Systems theory is a model of the living, conscious, social fabric of Gaia. That's us!

Author

Kent Palmer is a Principal Systems Engineer at a major Aerospace Systems Company. He has a Ph.D. in Sociology concentrating on Philosophy of Science from the London School of Economics and

a B.Sc. in Sociology from the University of Kansas. His dissertation was on The Structure of Theoretical Systems in Relation to Emergence[5] and concerned how new things come into existence within the Western Philosophical and Scientific worldview. He has written extensively on the roots of the Western Worldview in his electronic book The Fragmentation of Being and the Path Beyond the Void[6]. He has at least twenty years experience[7] in Software Engineering and Systems Engineering disciplines at major aerospace companies based in Orange County CA. He served several years as the chairman of a Software Engineering Process Group and now is engaged in Systems Engineering Process improvement based on CMMI. He has presented a tutorial on "Advanced Process Architectures[8]," which concerned engineering wide process improvement including both software and systems engineering. Besides process experience he has recently been a software team lead on a Satellite Payload project and a systems engineer on a Satellite Ground System project. He has also engaged in independent research in Systems Theory which has resulted in a book of working papers called Reflexive Autopoietic Systems Theory[9]. A new introduction to this work now exists called Reflexive Autopoietic Dissipative Special Systems Theory[10]. He has given a tutorial[11] on Meta-systems engineering to the INCOSE Principles working group and a paper on the same subject in the INCOSE 2000 conference proceedings. He has written a series on Software Engineering Foundations which are contained in the book Wild Software Meta-systems[12]. He has taught a course in "Software Systems Requirements and Design Methodologies" at University California Irvine Extension.

IDENTIFICATION PAGES

[5] http:// dialog.net:85/homepage/disab.html
[6] http:// dialog.net:85/homepage/fbpath.htm
[7] http:// dialog.net:85/homepage/resume.html
[8] http://dialog.net:85/homepage/advanced.htm
[9] http://dialog.net:85/homepage/refauto2.htm
[10] http://dialog.net:85/homepage/autopoiesis.html
[11] http://dialog.net:85/homepage/incosewg/index.htm
[12] http://dialog.net:85/homepage /wsms.htm

Title of Paper: META-SYSTEM ENGINEERING FUTURES

_____
_____
_____

Technical Tracks associated with paper (indicate 1, delete those which don't apply)

*** Education & Research**

_____
_____
_____
____

Areas of Special Interest associated with paper (indicate 1, delete remainder)

Systems engineering research

_____
_____
_____

Author's Information: *(for Brian Mar Student Award)*

Professional

Intended Audience (*indicate all that apply, delete others)*:

Experienced Practitioner
Academics

Researcher

Recommended Expertise of Reviewer (indicate one or more, delete others):

Research