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Systems Engineering Newsletter (SyEN)

SyEN#034 - July 27, 2011

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Dear Colleague,

SyEN is an independent free newsletter containing informative reading for the technical project professional, with scores of news and other items summarizing developments in the field, including related industry, month by month. This newsletter and a newsletter archive are also available at www.ppi-int.com.

Systems engineering can be thought of as the problem-independent, and solution/technology-independent, principles and methods related to the successful engineering of systems, to meet stakeholder requirements and maximize value delivered to stakeholders in accordance with their values.

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A Quotation to Open On

"Those who cannot remember the past are condemned to repeat it." - George Santayana

Life of Reason, Reason in Common Sense, chapter 12, 1905-6

Feature Article

Dealing with Chaotic Systems: A Systems Engineering Perspective

By Dr Jan Roodt – StoneToStars Limited, New Zealand
Jan.roodt.nz@gmail.com

Member of INCOSE South Africa

Introduction

In a previous article on chaos, the focus was on the core concept of chaos. I considered simple examples to show that chaotic systems evolve rapidly in unpredictable ways. This happens despite the fact that the systems can be shown to be deterministic. It was noted that any noise may shift the system into a new trajectory and even noise and inaccuracies introduced during measurement will contribute to these effects. This means that our measurements may be exactly the process the causes the data to be useless in prediction or in extracting the underlying system characteristics.

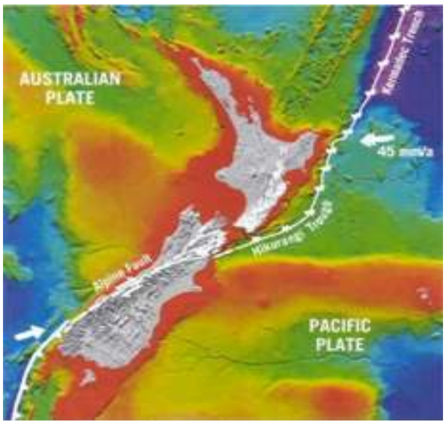
I showed that there were known mathematical techniques to try to identify chaotic dynamic systems and to separate them from the systems with truly random behaviour. The problem is that most of these techniques rely on very good and representative data, which leads to the infernal situation I described above.

In this short piece, I will propose simple approaches that may be useful in identifying and dealing with chaotic systems. It is not useful to go into intricate mathematics here, but a few mathematical procedures will be mentioned for completeness sake before developing to a "workflow" that can be used on complex projects. I hope that this will open up some debate and feel free to mail me at the supplied e-mail address above with your comments.

The problem with trying to discover chaotic systems

This is probably not the best way to start an article in a technical publication, but, I guess, the truth remains that the mathematics associated with complexity sciences and chaos is not always the easiest to handle and although many of the concepts make sense in one or even three dimensions, it becomes exceedingly difficult to imagine things when we deal with higher order systems.

The same applies to the theoretical tools that are being developed to try to look for chaotic behaviour in systems. In the previous article on this topic, the concept of attractors was discussed. It is beneficial to look for chaos related patterns in data, because we highlighted the fact that chaotic systems are in fact deterministic, and not random. We can do little about random events, but we should do something about things that are deterministic. If we can identify the chaotic system, we can work on short-term predictions and if we can do that, we can identify patterns as precursors to catastrophic events or failures. That is the theory.



It is important to note that the tools we developed up to now are not that strong at revealing the details of underlying laws of the universe, and it does not allow us necessarily to develop characteristic parametric equations to describe the phenomena with [1]. There is no simple parametric equation set for earthquakes, for example. To be able to look for chaos, one of the first steps is to reconstruct the phase space and hopefully attractors. The search continues for a reliable method to reconstruct higher order attractors. It is also difficult to estimate the dimensionality of the attractor, because in practice large data sets are required [2].

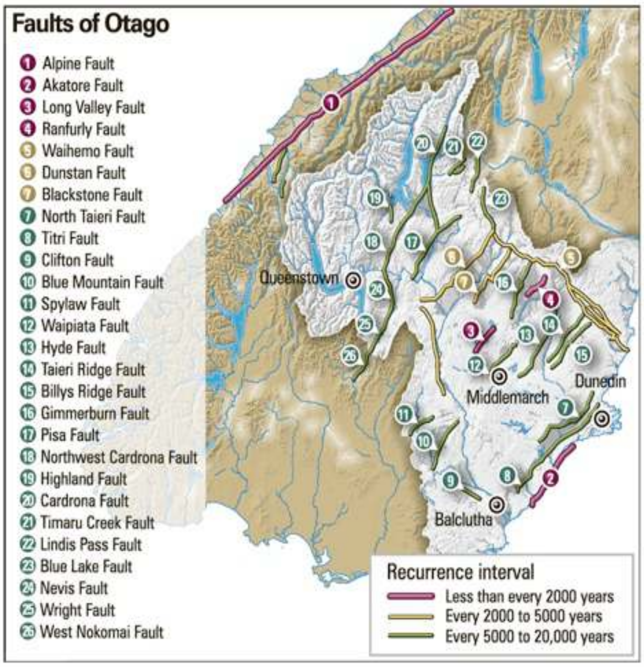
We have seen before that it is possible to inspect large data sets with Fast Fourier Transform techniques to establish power spectral density. If the data is from a completely random source, then all frequencies under inspection should have equal weighting. However, if there is any oscillation, it should show up as peaks in such a spectrum graph. If there is any periodicity, we should be able to pick this up. Indeed, that is good in theory, but if we take a system like plate tectonics, the data may be filled with noisy sources.

Another approach is to try to calculate the Lyapunov exponents from measured data. Remember that chaotic systems have this uncanny behaviour that even if, we know the initial condition of a system, it becomes exceedingly difficult over time to predict in what state the system will be in. If we start a chaotic system difference equation from the same initial point x0 at time t0 and then introduce small perturbations, we know that the system will evolve differently every time. The Lyapunov exponent is an indication of the average separation of system trajectories that started from the same initial condition or point in time [3]. A positive exponent indicates that we are dealing (possibly) with a chaotic system. However, a sure-fire way of computing this number from real-world data still eludes us.

Other techniques that you will encounter in the chaos literature include the Kolmogorov-Sinia Entropy measure (which needs extensive, relatively noise free, data sets and massive computing power) and Mutual Information Redundancy techniques. As always, no single approach will crack this problem, but the search continues. Using several techniques may be useful in giving a strong indication of whether you are dealing with a chaotic system.

How chaotic systems can crop up in your engineering project

It is probably good to mention a few processes that can have an influence on your projects. The weather is one of the best-known chaotic systems. We know that weather forecasts are more often than not of very little use to us when we need to plan for specific events. Weather can be predicted reasonably well on a macros scale, but only when a tornado starts developing do we have enough information to try to predict its path, that is, looking at the micro scale.

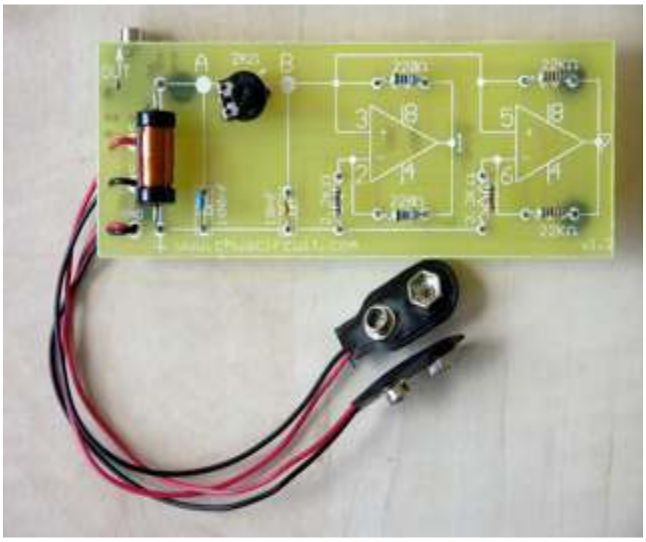


Earthquakes are part of dynamic earth systems, but it is very difficult to predict an earthquake and seemingly impossible to say anything about the magnitude of earthquakes in any region of the world. Despite good geological record keeping in quake prone regions, we still cannot say with any certainty when a quake will hit. In some regions, we know that massive earthquakes have a periodic cycle of a few hundred years, but that sort of information is not very useful, as it is not specific enough to plan a building project that may have a limited life cycle of say half the period of expected quakes. One can make no good judgment call to save money on such a project. On the other hand, it is not useful to over-design, just in case.

In an article in the Otago Daily Times in March 2011, just after the second Christchurch earthquake, Ellie Constantine wrote an interesting article that showed all the fault lines in the Otago region of New Zealand [4].

The map is from that piece and it shows major fault lines in the region as well as expected periodicity. As we have learnt from the previous article in this newsletter, it takes only a small perturbation to switch a chaotic system into a new state, which means that any of these fault lines may be activated at any time. It is just a case of us knowing that some are activated more frequently than others, no more, and no less.

You may say that chaos will not affect your electronic engineering project, but did you consider that it is known that some simple electronic circuits will operate in a chaotic (oscillatory) domain under certain circumstances? In fact, it is simple to construct electronic systems that exhibit chaotic behaviour. In addition, in the near future some of these circuits may find their way into nano-scale electronics, like the memristor, initially proposed by Leon Chua and implemented by HP in 2008. The simplest Chua circuit is shown below [5]:



It uses capacitors, resistors, inductors and in this case two JFET op amps used as voltage-controlled resistors. Under specific values of these components, the circuit above will demonstrate chaotic behaviour. For those without the simulation tools, a simple simulator can be found on the web [6].

We have many examples in the civil construction field where structures were destroyed as a result of entering an oscillatory domain that was not foreseen. Nowadays civil engineers pay attention specifically to the effect of wind flow, temperature fluctuations and flow and the movement of people inside and over structures.

The problem in each and every case, and probably in many that you can think of now as you read this, is that it is not very helpful to get the detailed data after the disaster, and given that we now know that any macro data set may be of very little use to predict the following event, it is clear that we may need other approaches to deal with chaos in a pragmatic manner. This does not mean that scientists should not continue to search for more reliable ways to model and predicts some of these events; it just means that as engineers we need to find workable solutions to the situations we face every day and that we need to take note of these phenomena as we design these solutions.

A workflow approach

Another way of approaching this dilemma is to consider a process that will minimize risk by allowing us to manage the impact of systems that may possibly be susceptible to chaotic behaviour or even just those systems that belong to the complex domain. In "A Leader's Framework for Decision Making", Snowden and Boone proposes a way for dealing with chaos and complexity as part of the Cynefin framework [7]. While recognizing that this is a framework and not a mathematical or engineering toolbox, it is also true that finding solutions and risk management are at the heart of engineering. Making sense is crucial to developing solutions.

The Cynefin framework is depicted below and a short description of each domain follows. In the Simple domain, the relationship between cause and effect is obvious. This is the domain of “Best Practice”. There are clear causal relationships, easily discernable by everybody.

When the relationship between cause and effect requires analysis or others form of investigation and/or the application of expert knowledge, we enter the domain of the *Complicated*. Multiple “right” answers exist and although causal relationships are there, not everybody can see them.

In the *Complex* domain, the relationship between cause and effect cannot be perceived in advance, but only in retrospect. This is known as emergence, and by doing experiments in a so-called “safe-to-fail” environment, it is possible to discern instructive patterns. Appropriate models in the right simulation environments may be used as laboratories to discover these patterns.

Our interest is in the *Chaotic* domain. Here there is no relationship between cause and effect at systems level according to Snowden and Boone. They say that it is pointless looking for the right answers or cause of action in this domain, and rapid response is often the only way of dealing with the situation. This makes sense if we consider that chaotic systems change in unpredictable ways, not because of the randomness, but rather because the trajectories of the system may diverge based on small perturbations. The key here is “rapid response”.

The problem with rapid response is that it relies on the experience of people, and in many cases on the experience of people with years spent in a certain environment. Gary Klein [8] explains that we use mental simulation to explain cues and information in non-routine decision making. This relies on experienced people being able to judge something as being familiar or typical, or not. What if something looks like a typical situation, but at the last moment it transpires to be something else? Klein uses the example of the USS Vincennes that shot down an Iranian Airbus in 1988. The behaviour of the Airbus looked like that of an F-14 to the crew of the Vincennes and in this case, the engagement ran for approximately seven minutes. This can clearly be classified as a situation that fits within the chaotic regime. There was no time to gather extensive data, no time to construct any of the dimensions of the ‘engagement system’ and to see if they were deviating markedly from developing from the initial state that was assumed. The captain relied on the centralized information system to make the decision, despite some of his officers offering alternatives to the situation as it was presented.

The captain of the ship had to either shoot down the incoming plane (designated as an enemy by a certain time) or risk certain damage to his own resources: this was his evaluation of the situation at the time. Sometimes it comes down to understanding core principles of operation. In many cases the call is made from the basis of ethics or moral conviction.

Recently an automated system in the Pacific generated a Tsunami warning for New Zealand after a large ocean bed earthquake off the Kermadec Islands (see image) [9]. New Zealand was put on high alert, but after local experts evaluated the situation, the potential threat was downgraded. A decision was reached that in future the local civil defence organization would conduct its own assessment (also using other sources of information about the same event) before issuing an alarm. This means that the central system for warning would still be used, but in a way, distributed decision-making would be used to make a final call to action. This approach aligns itself with one of the methods that are used in formal chaos identification namely, Mutual Information Redundancy.

Concluding remarks

Many more examples can be found, especially in the work of Klein above. It shows that any system that we design for the modern world has to take into account the reality of chaos driven events impacting on it. The physical system itself can only be robustified so much, before the pragmatism of cost and achievability catches up with us. After that the system operational procedures must take care of the unexpected events. Relying on fixed doctrine and centralized control may not be the answer. The answer seems to lie with localized control and decision-making, but with inclusion of centralized information sharing systems. Obviously the more we understand what the functional requirements are of a system, if we understand in detail how it works and why it operates in a certain way (the purpose of the system), the better our chances of understanding how to cope with unexpected events.

Obviously we must try to estimate where these chaotic system elements may be hiding in our design, and we must try and develop risk abatement procedures to ensure the best possible decisions are made in a moment of chaos. This may include simulation of events and training that incorporate learning methods geared towards finding novel solutions based on ethical and morally defensible premises. All the time we must remind ourselves that we cannot rely so heavily on our sense of causality anymore.

Because chaotic systems can depart rapidly over tome from known trajectories, we need to face up to the fact that we cannot design for all the possible outcomes when we deal with modern complex systems. At the same time we need to take the responsibility to do everything that is reasonable to design process and procedures for utilization that acknowledges chaos. Taking care to identify the parts of a system that may introduce emergent behaviour or chaotic outcomes must be built into the requirements analysis process and the broader system specification. This is the first step, and as we learn more we will be able to get a better handle on this aspect of our responsibility to supply safe working solutions for the messy problems of the world we live in.

References

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[2] R. C. Hilborn, *Chaos and Nonlinear Dynamics: An introduction for scientists and engineers.*, Second ed. New York: Oxford University Press, 2000.

[3] D. Kaplan and L. Glass, *Understanding Nonlinear Dynamics*. New York: Springer, 1995.

[4] E. Constantine, (9 March 2011) *Dunedin residents 'should not be complacent'*, Otago Daily Times, Dunedin, New Zealand,

Available: http://www.odt.co.nz/news/dunedin/150965/dunedin-residents-should-not-be-complacent

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[7] D. J. Snowden and M. E. Boone, "A Leader's Framework for Decision Making", *Harvard Business Review,* Reprint, 2007.

[8] G. Klein, *Sources of Power: How people make decisions*. London: The MIT Press, 1999.

[9] TVNZ. (2011, 20 July 2011). *Pacific Tsunami Centre admits alerts too alarmist*. Available: http://images.tvnz.co.nz/tvnz_images/news2011/disaster_overseas/kermadec_quake_2.jpg

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Systems Engineering News

APCOSE 2011

By Cecillia Haskins

If you too are curious or committed to applications of systems engineering to issues and challenges of sustainability, join APCOSE this October.

More information

De Weck and Co-Authors Win Best Paper Award

The International Council on Systems Engineering (INCOSE) has selected the *Systems Engineering* paper by Eun Suk Suh, Michael Furst, Kenneth Mihalyov and Olivier de Weck to receive the journal's 2010 Best Paper of the Year Award. The paper, "Technology Infusion for Complex Systems: A Framework and Case Study" discusses a new methodology for assessing the merits of a technology, not in isolation but in the context of the host system in which it is integrated.

More information

INCOSE eNote July 2011 v8 Issue 6 released

In this issue:

- IS2012 Call for Papers
- Call for Papers CSER 2012
- Upcoming Events

More information

MITRE Produces Online Systems Engineering Guide

By Cecillia Haskins

The MITRE Corporation has published a free, online Systems Engineering Guide (SEG) as a way to share the knowledge that the not-for-profit organization has accumulated in its more than 50 years of service to the United States federal government. The SEG, which features the collective wisdom of more than 130 of the company's most highly regarded systems engineers, is organized into an easily accessible format.

More information

CASoS Engineering Initiative

The roots of the Complex Adaptive Systems of Systems (CASoS) Engineering Initiative grew in the fertile soil of the National Infrastructure Simulation and Analysis Center (NISAC) program at Sandia National Laboratories (Sandia). In 2002 Sandia formed the Advanced Methods and Techniques Investigation group within NISAC to filter concepts from the Complex Systems literature that cross disciplines, and to identify study/modeling approaches that could be of direct use to NISAC. Sandia also worked to identify common unresolved issues pertaining to the application of Complex Adaptive Systems modeling to real-world situations and defined the R&D effort for Complex, Interdependent Adaptive Infrastructure to resolve the issues of greatest importance to NISAC.....

More information

Presentation on CASoS

INCOSE Pioneer Award

The Pioneer Award is presented annually to one distinguished individual or team, who by their achievements in the engineering of systems, has contributed uniquely to major products or outcomes enhancing society or its needs. The criteria may apply to a single outstanding outcome or a lifetime of significant achievements in effecting successful systems.

The Pioneer Award recognizes outstanding pioneer-applications of Systems Engineering in the development of successful products or services of benefit to society. Examples include applying systems engineering principles to unique, highly complex problems; the successful application of systems engineering to brand new market segments; and outstanding examples of advancing the state of the art and /or practice of systems engineering beyond its current bounds.

At the recent INCOSE International Symposium in Denver, two more pioneers were awarded:

Xue-Shen Qian

Citation: For devoting his whole life to the work of science and technology for the benefit of humankind

Dr Azad Madni

Citation: For recognition in the crucial frontiers of systems engineering and working effectively to advance the theory, tools and products required for the future of our profession.

TASC, Inc. Forges Systems Engineering Certification Agreement with INCOSE

TASC, Inc. and the International Council on Systems Engineering have signed an agreement to promote INCOSE's certifications to qualified TASC engineers. Under the agreement, TASC employees will have easier access to all INCOSE systems engineering certifications, from entry level to foundation level to senior level.

More information

INCOSE INSIGHT July 2011, Vol 14 - Issue 2 Released

The July 2011 INSIGHT is ready to view or download on INCOSE Connect.

Special Feature: Systems of Systems and Self-Organizing Security

Rick Dove and Jennifer Bayuk have led a team of contributors from across the spectrum of systems engineering, software engineering, system security engineering, and human systems integration to produce a very informative issue of INSIGHT. The articles in this issue substantiate the claim that Rick and Jennifer make in their introduction:

From concept to operations, theory meets practice, and practice informs and refines theory. Where the frontier is in systems of systems or self-organizing systems, that learning loop can be fastest where the stakes are highest. Perhaps nowhere else are the stakes higher than where systems become high-value targets under attack by determined, intelligent adversaries. Systems security provides an accelerated learning arena for testing and vetting theories of systems of systems and self-organizing systems.

Systems Engineering Volume 14, Issue 3

The latest issue of Systems Engineering is available on Wiley Online Library

More information

Systems Thinking/Systems Thinking World Merger Info & Feedback

Based on discussions between Ben Taylor and Gene Bellinger, efforts are underway to effect a merger of the Systems Thinking and Systems Thinking World groups. It seems these two groups are sufficiently similar that it is causing confusion among the members.

Consideration has been given to which direction the merger should take place and it appears that merging the Systems Thinking group into the Systems Thinking World group would result in a disruption for the fewest members and active discussions.

It is the intention to ensure that relevant discussion concepts and references are not lost as a result of this merger. While the specific details of the sequence for this merger are still developing, a current state of thought can be found at... http://bit.ly/kvP41M

Discussions have been created in both groups for members to provide feedback to ensure they don't lose any relevance and ensure that they're leveraging the potential value of the merge.

More information

INCOSE Honors its First Transportation Engineer with the Prestigious Founders Award

The International Council on Systems Engineering (INCOSE) has honored New York City-based Anne O'Neil with its prestigious Founders Award for her contributions to the organization's representation of transportation systems engineers. This is the first time the world's most prestigious systems engineering organization has honored a transportation systems engineer. The Founders Award recognizes outstanding individual contributions to INCOSE.

More information

Systems Thinking Tools Give Sustainability Deep Traction

In October 2009, the US Partnership for Sustainable Development published Version 3 of its National Education for Sustainability K-12 Student Learning Standards. It is an attempt to codify what "students should know and be able to do to be sustainability literate." The Student Learning Standards are also called "Essential Understandings" by the US Partnership.

More information

Ask Robert

Q? What is the role of success criteria valuation in project risk management?

A: The answer to this question lies in the nature of risk – risk is an expected loss with respect to a valued outcome. If there is certainty that all valued outcomes will be achieved, there is no risk. If a certain outcome has no value (positive or negative), there can be no risk with respect to that outcome.

And so, performing project risk management starts with an understanding of the value of outcomes sought from a project, then continues by assessing the risk with respect to achievement of those outcomes, collectively (overall risk) and/or individually (e.g.

cost risk, schedule risk, risk to capability). Unless stakeholders are *totally* risk averse (which *never* occurs), project risk management must also be concerned with opportunity – an expected gain with respect to (i.e. beyond) a valued outcome. Opportunity may justify taking risk. In fact, if the opportunity exceeds the risk, a course of action, which pursues the opportunity, should be taken, unless resources are finite and there is an alternative course of action for which the beneficial difference between opportunity and risk is even greater. All of the above is fundamentally driven by what is important in terms of outcomes, and how important!

Outcomes may be expressed in two forms. The first is requirements – outcomes that must be achieved. These are sometimes called thresholds. There is, of course, always risk with respect to satisfying requirements. The second is goals – outcomes that are to be pursued but not necessarily achieved. These are sometimes called objectives. With a reference of *just* meeting requirements, any potential outcome which adds value by complete or partial achievement of a goal represents an opportunity.

Accordingly, to assess and effectively manage risk, both requirements (threshold of acceptability) and goals (targets beyond the threshold of acceptability) must be valued. It is appropriate to value each requirement by the amount of damage done if that requirement were not met. Objective methods exist for this purpose, e.g. the Compromise Impact Value method.

It is appropriate to value goals by the relative value of each improvement from threshold of acceptability to goal, together with the function describing the amount of value added as an outcome improves from the threshold of acceptability (requirement) level to the goal level. The values of achievement towards multiple goals must be expressed in common units and combined. The building of a system or project effectiveness model achieves this summation, normally using Multiple Attribute Utility Theory (MAUT).

And so, this value information feeds directly into assessment of the amount of risk. Risk is linearly proportional to the value of an outcome. Double the value, the risk is doubled.

Robert Halligan, FIE Aust

Featured Society – Modelica Association

The Modelica Association is a non-profit, non-governmental organization with the aim of developing and promoting the Modelica modeling language for modelling, simulation and programming of physical and technical systems and processes, e.g., mechanical, electrical, electronic, hydraulic, thermal, control, electric power or process-oriented subcomponents. The Modelica Association owns and administrates incorporeal rights related to Modelica, including but not limited to trademarks, the Modelica Language Specification, Modelica Standard Libraries, etc., which should be generally available for the promotion of industrial development and research.

Modelica is a free, object-oriented modeling language with a textual definition to describe physical systems in a convenient way by differential, algebraic and discrete equations. A Modelica modeling environment is needed to edit or to browse a Modelica model graphically in form of a composition diagram (meaning a schematic). A Modelica translator is needed to transform a Modelica model into a form (usually C-code) which can be simulated by standard tools. The following document, available at https://www.modelica.org/, specifies the Modelica language:

The Modelica Specification, version 3.2 (PDF format, 1599 Kbyte) is the official definition of the Modelica language and includes the grammar, the semantic specification and a definition of the built-in operators.

The Modelica Association has both Organizational and Individual member grades. The Association is lead by a Board comprising a Chairman (presently Martin Otter, DLR Oberpfaffenhofen, Germany), Vice-Chairman, Treasurer and Secretary.

More information

INCOSE Technical Operations

Anti-Terrorism International Working Group

http://www.incose.org/practice/techactivities/wg/ati/

Charter

The Charter of the Anti-Terrorism International Working Group (ATIWG) is to demonstrate the use of systems engineering principles, techniques, and practices to the reduction and eradication of international terrorism. The systems engineering approach is most amenable to such evaluations because of its use of multi-disciplines to examine all facets of the problem space.

Leadership

Co-Chair: William Mackey, Computer Sciences Corporation

Co-Chair: Joe Carl, Harris Corporation

Co-Chair: Steven Sutton, Northrop Grumman

Co-Chair: Jerry Nolte

Contact Anti-Terrorism International Working Group for additional information or to join this group.

Accomplishments/Products

- Two papers were presented at the INCOSE 2003 Symposium in Arlington, VA. These papers may be found as part of the INCOSE 2003 Symposium Proceedings. These papers are:

· Mackey, William; Crisp, Harry; Cropley, David; Long, James; Mayian, Stephen; and Raza, Shabaz, "The Role of Systems Engineering in Combating Terrorism", *INCOSE 13 th Annual International Symposium Proceedings*, Washington, DC, July 2003. (Mackey, W. et al., 2003)

· Long, J. and Mackey, W., "Systems Engineering Modeling Useful in Combating Terrorism", *INCOSE 13 th Annual International Symposium Proceedings*, Washington, DC, July 2003. (Long and Mackey, 2003)

Three panels were presented at:

· The INCOSE 2002 Symposium in Las Vegas, NV" The Role of Systems Engineering in Combating Terrorism"

· The INCOSE 2003 Symposium in Arlington, VA" The Role of Systems Engineering in Combating Future Acts of Terrorism"

· The INCOSE 2004 Symposium in Toulouse, France

· The INCOSE 2005 Symposium in Rochester, NY

· The INCOSE 2006 Symposium in Orlando, FL

· The INCOSE 2007 Symposium in San Diego, CA

"Recent Systems Development and Legal Efforts To Secure National Borders in the U.S., Europe, Israel, and Iraq"

INSIGHT Issue

· July 2006, "The Use of Systems Engineering in Emergency Preparedness"

Current Projects

- *Project 1 - Root Cause Analyses*
- The ATIWG is conducting an analysis of the root causes of terrorism using the Ishikawa Fishbone Diagrams.
- The ATIWG is requesting a review of the initial results by the interested members of INCOSE.

- *Project 2 - Partnerships Creation*
- The ATIWG is seeking partnerships with national government, state government, and academic institutions that would accept support from a voluntary organization such as INCOSE.

2008 International Workshop ATIWG Summary Presentation Size: 200K

Systems Engineering Software Tools News

Cradle® July 2011 Newsletter

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18. Acrobat Compatibility
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More information

Cognition Corporation Teams Up with Netherlands Based Synergio to Expand European Distribution of Cockpit

Cognition Corporation announces their new partnership with Netherlands based Synergio, a European distributor specializing in Requirements Engineering. Together with Synergio, Cognition Corporation is expanding their European distribution of the Cockpit requirements management tool to Scandinavia, Germany, and the Benelux region of Europe.

More information

Systems Engineering Books, Reports, Articles and Papers

Systems Thinking, Third Edition: Managing Chaos and Complexity: A Platform for Designing Business Architecture

by Jamshid Gharajedaghi
Publisher: Morgan Kaufmann; 3rd edition (July 13, 2011)
ISBN-10: 0123859158
ISBN-13: 978-0123859150

Review:

Einstein once wrote, "Without changing our pattern of thought, we will not be able to solve the problems we created with our current patterns of thought." Jamshid develops a pattern of thought that will yield solutions to those problems. - Russell Ackoff, Professor Emeritus, The Wharton School, University of Pennsylvania

Gharajedaghi challenged us to think backwards from an ideal competitive position instead of forwards from our existing position with all its constraints. The result was bolder thinking about change. Jamshid forces a realistic assessment of a company's strengths and weaknesses, an idealistic view of what it could be, and creates the path from point A to point B. - Bill Tiefel, President, Marriott Lodging

Gharajedaghi was perfect! He had passion and brilliance. He could challenge our traditional thinking and make us see our actions and opportunities from a different perspective. - William G. Poist, President and CEO, Commonwealth Energy System

More information

Can Systems Thinking Revolutionise Your Customer Service?

Posted by Bryan Himsworth in Customer experience on Fri, 17/06/2011

Viewing your organisation from the customer's perspective is, of course, the best way to improve customer service. And this way of working is the central tenet of systems thinking which examines how customers draw value from the process of interacting with an organisation and conversely, how the design of an organisation and its processes can drive poor service and poor performance.

More information

Journal of Enterprise Transformation

An official journal of the Institute of Industrial Engineers (IIE) and the International Council on Systems Engineering (INCOSE).

Large and complex organizations need to continuously adapt to changes in the global environment, economies, and markets. This adaptation requires solutions that consider the role of organizations, knowledge, information, processes, strategy, and technology. This holistic approach integrates the needs of multiple stakeholders to create value and enable enterprise transformation.

The ***Journal of Enterprise Transformation (JET)*** is a quarterly publication designed to provide a forum for original articles on trends, new findings, and ongoing research (both theory and application) related to enterprise transformation.

More information

Systems Thinking: The Essence and Foundation

The Systems Thinking Approach® is synonymous with Systems Thinking and Strategic Thinking. In essence, Strategic Thinking and Systems Thinking view individuals and organizations within the context of their environments.

As such, people and an organization do not exist as an island unto themselves, but as part of a larger network, web or matrix of systems that all function, more or less independently, yet interdependently.....

More information

SD-24 Value Engineering: A Guidebook of Best Practices and Tools

This publication shows how VE (Value Engineering) can be an effective mechanism for generating cost savings or cost avoidance for contractors and the U.S. Government, gives details on the basics of the VE methodology, discusses how to establish a VE program, describes best practices for applying VE on government contracts, and provides an overview of the benefits of a strong VE program.

More information

Systems Thinking and the Cost of Emotion

By Cody Romano

Ricardo Valerdi, a faculty member in MIT's System Design and Management (SDM) Program, surprised his students in a lecture hall earlier this year when he jotted "How to Calibrate Your Optimism" in large letters across a whiteboard.

"When you start talking about psychology," says Valerdi, laughing, "engineers usually feel uncomfortable at first. They're used to the technical approach — in understanding the math behind the model. But the psychological aspects can be equally, if not more, important."

Since he started teaching SDM's Cost Estimation and Measurement System course four years ago, Valerdi has frequently posed a unique and challenging question to his students: how does human decision-making, which includes factors like optimism and cynicism, influence the cost of complex systems?

More information

The 3 Blind Men of Systems Thinking and Complexity Science

The subject of complexity and its sister field of systems thinking are fascinating areas for research. In a single swoop, many of the concepts that underpin these areas can provide an explanation for so many apparently unrelated phenomenon, ranging from star formation to market collapses to epidemics. But the application of these ideas and concepts to business seems to fall short of gaining widespread acceptance or generating commercial value.

Many well-read executives are aware of STC or Systems Thinking and Complexity concepts ranging from interdependence and interaction, feedback, nonlinearity, sensitivity to initial conditions, to self-organization and emergence. They have also read about how some Fortune 500 and multinational companies have applied a few of these principles to improve their businesses. But when it comes to translating these ideas to their own business, they seem either confused or skeptical. Could this be because of a shortage of people who can effectively straddle the two universes of conceptual thinking and practical operations?....

More information

The Five Keys to Systems Thinking

By: Ronald B. Pickett - Published: July 13, 2011

1. Structure drives behavior. The way your organization is structured—flat, cross-functional, hierarchical or “siloed”—will drive the way your staff behaves.

2. Think operationally, not correlationally. Watch the way things actually work and the way the parts fit together, especially when they are perturbed, rather than how you think they work.

3. Everything important has a cause and effect relationship, and the cause and effect may not be closely related in space and time. Don’t get tied up in the purity of this approach; smoking really does cause cancer. This is an extension of thinking operationally. Find an “effect” and look for the cause.

4. Break away from linear thinking. Begin to have a “stone in the lake” view rather than a “leaf in a stream” view of the world.

5. Challenge the current mental models. We have models in our minds about how things work; learn to question those models. Develop new and possible or trial models. Play with the implications. “Suppose” and “What if ?” are the key concepts for Systems Thinking (ST).

More information

Outside Influences on Systems Engineering

A Company Grade Officer’s Observations in the Aftermath of a Difficult Project

Capt. J. Morgan Nicholson, USAFR

In the world of acquisitions management, the systems engineering discipline is often thought of as a separate independent activity that follows a certain flow chart and, if executed correctly, produces a useable item that meets the technical requirements within cost and schedule constraints. This is a fallacy that has no doubt led to many project failures, including the case study presented here. To make matters worse, decisions made in areas thought to be outside of systems engineering are often the root cause of a project’s failure. These non-technical decisions have a direct effect on the project’s technical performance…..

More information

Using Hypermedia in Requirements Engineering Practice

Abstract

In the literature, proposals can be found to use hypermedia for requirements engineering. The major technical and commercial constraints for wide-spread application are removed now, but there is little knowledge generally available yet on exactly how such approaches can be applied usefully in industrial practice, or what the advantages and issues to be solved are.

So, we report on a case study of using hypermedia ‘real-time’ in the requirements phase of an important real-world project inside our environment, where several ways of applying hypermedia were tried with varying success. Since the resulting hypermedia repository can be fully automatically exported into a Web representation, several versions were made available on the intranet at different stages. While this case study may serve as a data point in the space of such applications, we also discuss reflections on this experience with the motivation of helping practitioners apply hypermedia successfully in requirements engineering. In a nutshell, this paper presents some experience from using hypermedia in requirements engineering practice, and a critical discussion of advantages and issues involved.

More information

Journal on Software and Systems Modeling

Theme Issue on Model-Driven Service Engineering

Service Oriented Development (SOD) has become one of the major research topics in the field of software engineering, leading to the appearance of a novel and emerging discipline called Service Engineering (SE), which aims to bring together benefits of Service Oriented Architecture (SOA) and Business Process Management. SE focuses on the identification of services (a client-provider interaction that creates value for the client) as first class elements for the software construction. The convergence of SE with Model-Driven Engineering (MDE) can hold out the promise of rapid and accurate development of software that serves software users' goals.

MDE deals with promoting the role of models as primary actors in any task related with software development. Its main principles are to raise the level of abstraction at which software is specified and to increase the level of automation. One of the main advantages of model-driven approaches is the provision of a conceptual structure where the models used by business managers and analysts can be traced towards more detailed models used by software developers.

This kind of alignment between high level business specifications and the lower level SOAs is a crucial aspect in the field of SOD, where meaningful business services and business process specifications are those that can give support to the real business environment which is changing with increasing speed.

More information

Insights and Tools for Smart Governments

Throughout history, municipal governments have tried to provide their citizens with essential public services. But in making the most of taxpayer money, these governments have often been muddled by the complexities of administrating "systems of systems"…..

More information

Conferences and Meetings

46th Annual International Logistics Conference and Exhibition (SOLE 2011)

August 2011
More information

NASA Goddard Space Flight Centre (GSFC) Systems Engineering Seminar NEW

First or second Tuesday of every month at 1:00 to 3:00 p.m. in the GSFC Building 3 Auditorium

August 2, 2011, 1:00 pm - Case Studies in Software Safety: Accidents and Lessons Learned

September 13, 2011, 1:00 pm - Small Rocket/Spacecraft Technology (SMART) Platform

November 1, 2011, 1:00 pm - GSFC Science Mission Directorate, Code 600

December 6, 2011, 1:00 pm - NASA Engineering and Safety Center (NESC)

More information

ISSC 2011 - 29th International System Safety Conference

Aug 8, 2011 - Aug 12, 2011, Las Vegas, Nevada, USA

Mayo Clinic Conference on Systems Engineering and Operations Research in Health Care

August 10 - 12, 2011, Rochester, Minnesota Kahler Hotel
More information

2011 Air Force Systems Engineering Conference NEW

August 16 – 18, 2011, Dayton, OH, USA

More information

21st International Conference on Systems Engineering (ICSEng 2011)

Las Vegas, NV USA , August 16 - 18, 2011
More information

IHMSC 2011 - International Conference on Intelligent Human-Machine Systems and Cybernetics

Aug 26, 2011 - Aug 27, 2011, Hangzhou, China
More information

TEAR 2011 : Trends in Enterprise Architecture Research (TEAR) Workshop

August 29, 2011, Helisinki, Finland
More information

19th IEEE International Requirements Engineering Conference and Workshops NEW

- W1: Requirements Patterns (RePa'11)
- W2: Model-Driven Requirements Engineering (MoDRE)
- W3: Requirements Engineering Education and Training (REET)
- W4: Requirements Engineering for E-Voting Systems (REVOTE)
- W5: Requirements Engineering for Social Computing (RESC)
- W6: Software Product Management (IWSPM'11)
- W7: Requirements Engineering and Law (RELAW 2011)
- W8: Requirements @ run.time
- W9: Empirical Requirements Engineering (EmpiRE)
- W10: Requirements Engineering for Systems, Services, and Systems of Systems (RES^4)
- W11: Fourth International Workshop on Multimedia and Enjoyable Requirements Engineering (MERE'11)
- W12: Fourth International Workshop on Managing Requirements Knowledge (MaRK'11)

August 29 – September 2, 2011, Trento, Italy

More information

Fifth International i* Workshop (iStar'11)

Held in conjunction with the International Requirements Engineering Conference
August 29-30, 2011, Trento, Italy

More information

Workshop on Requirements Engineering for Systems and Systems-of-Systems

Held in conjunction with the International Requirements Engineering Conference
August 30, 2011, Trento, Italy

More information

Workshop on Dependable Systems of Systems

September 5 – 6, 2011, The Ron Cooke Hub, Heslington East Campus, University of York

More information

19th International Conference on Case Based Reasoning

12-15 September 2011, Greenwich, London, UK
More information

AVOCS 2011 - 11th International Workshop on Automated Verification of Critical Systems

September 12th - 15th, 2011, Newcastle University, Newcastle upon Tyne, UK
More information

3rd Annual NASA Independent Verification and Validation Workshop

September 13 - 15, 2011, West Virginia University Erickson Alumni Center
More information

Engineering Lean and Six Sigma Conference 2011 NEW

September 12-14, 2011, Westin Atlanta Perimiter North, Atlanta, Ga, USA

More information

11th International Workshop on Automated Verification of Critical Systems - AVOCS 2011 NEW

12th - 14th September 2011, Newcastle upon Tyne, UK

More information

Summer School 2011: Verification Technology, Systems & Applications NEW

September, 19th-23rd, 2011, Montefiore Institute (University of Liège), Liège, Belgium

More information

International Conference on Industrial Engineering, Systems Engineering and Engineering Management for Sustainable Global Development

September 21-23, 2011, Spier Hotel and Conference Centre, Western Cape, South Africa
More information

SBMF 2011 - 14th Brazilian Symposium on Formal Methods

September 26-30, 2011, Sao Paulo, Brazil
More information

4th Euro Symposium on Systems Analysis and Design NEW

September 29, 2011, Gdansk, Sopot - Poland

More information

XXXIX Brazilian Congress on Engineering Education - COBENGE 2011

October 03-06, 2011, Himmelblau Hotel, Blumenau, Santa Catarina, Brazil
More information

SASO 2011 - Fifth IEEE International Conference on Self-Adaptive and Self-Organizing Systems

October 3-7, 2011, Ann Arbor, Michigan, USA
More information

IEEE SRDS 2011 - 30th International Symposium on Reliable Distributed Systems

October 4-7, 2011, Madrid, Spain
More information

Enterprise Transformation Conference NEW

October 4-5, 2011, The Westin Buckhead Atlanta, Ga, USA

More information

AGTIVE 2011 - International Symposium on Applications of Graph Transformation with Industrial Relevance

October 4-7, 2011, Budapest, Hungary
More information

9th International Symposium on Automated Technology for Verification and Analysis

October 11-14, 2011, Taipei, Taiwan
More information

The 12th International Conference on Web Information System Engineering (WISE 2011) NEW

October 13 – 14, 2011, Sydney, Australia

More information

MODELS 2011 - ACM/IEEE 14th International Conference on Model Driven Engineering Languages and Systems

Sun 16/10	W1	VARY	Variability for You
	W2	MPM	Multi-Paradigm Modeling
Mon 17/10	W3	EESSMod	Experiences and Empirical Studies in Software Modelling
	W4	Models@run.time	Models At Runtime
	W5	MoDeVVa	Model-Driven Engineering, Verification and Validation
Tue 18/10	W6	CMA	Comparing Modeling Approaches
	W7	ME	Models and Evolution
	W8	ACES MB	Model-Based Architecting and Construction of Embedded Systems

October 16-21, 2011, Wellington, New Zealand
More information

5th Asia-Pacific Conference on Systems Engineering NEW

October 19-21, 2011, Seoul, South Korea

More information

2011 MIT SDM Conference on Systems Thinking for Contemporary Challenges NEW

October 24-25, 2011, Massachusetts Institute of Technology, Wong Auditorium, Cambridge, MA, USA

More information

SSEE 2011 - Society for Sustainability and Environmental Engineering 2011 International Conference

October 24-26, 2011, Brisbane Convention & Exhibition Centre, Brisbane, Australia
More information

NDIA 14th Annual Systems Engineering Conference

October 24 - 27 2011, Hyatt Regency Mission Bay, San Diego, California, USA
More information

ICFEM 2011 - 13th International Conference on Formal Engineering Methods

October 25 - 28, 2011, Durham, United Kingdom
More information

CEBM 2011 - 2011 International Conference on Engineering and Business Management (CEBM2011)

Oct 28 - 30, 2011, Shanghai, China
More information

IIBA 2011 Conference

Oct 30 – Nov 3, 2011, Fort Lauderdale, Florida, USA
More information

21st Annual Systems Thinking in Action® Conference

October 31-November 2, 2011, Westin Seattle Hotel, Seattle, WA, USA
More information

ER 2011, 30th International Conference on Conceptual Modeling

October 31 - November 3, 2011, Brussels, Belgium
More information

PoEM 2011 - The 4th IFIP WG8.1 Working Conference on the Practice of Enterprise Modelling

November 2-3, 2011, Oslo, Norway
More information

INCOSE Michigan 2011 Great Lakes Regional Conference NEW

November 4 – 6, 2011, Dearborn, MI, USA

Moreinformation

Managing Industrial Engineering

November 7, 2011, Chicago, USA

More information

INCOSE UK Annual Systems Engineering Conference (ASEC) 2011

November 9 - 10, 2011, Scarman Training and Conference Centre, Warwick Conferences, University of Warwick, UK

More information

13th IEEE International High Assurance Systems Engineering Symposium

November 10-12, 2011, Boca Raton Marriott Hotel, 5150 Town Center Circle, Boca Raton, Florida, USA

More information

11th Annual CMMI® Technology Conference and User Group

November 14 - 17, 2011, Hyatt Regency Denver Tech Center, Denver CO, USA
More information

Brazilian Society of Dynamic Systems (SBDS) Annual Conference

16-18 November, 2011, Brasilia, Brazil
Website: www.sdsbrasil.org (under construction)

ICSSEA 2011 - 23rd International Conference Software & Systems Engineering and Their Applications

November 29- December 1st 2011, Paris, France
More information

10th Anniversary & Annual Infrastructure and Regional resilience 2011 Conference

November 29 December 1, 2011, Gaylord National Hotel & Convention Center in Washington, DC, USA

More information

23rd International Conference on Software & Systems Engineering and Their Applications NEW

November 29 – December 1, 2011, Paris, France

More information

Haifa Verification Conference 2011 (HVC 2011) NEW

Organized by IBM R&D Labs in Israel

December 6th – 8, 2011, Haifa, Israel

More information

Complex Systems Design & Management (CSDM) 2011 NEW

December 7-9, 2011, Cite Universitaire, Paris (France)

More information

2nd IEEE International Conference on Networked Embedded Systems for Enterprise Applications - NESEA 2011 NEW

December 8th – 9, 2011, Fremantle, Perth, Australia

More information

Eighth Asia-Pacific Conference on Conceptual Modelling (APCCM 2012) NEW

January 30 - February 02, 2012, RMIT, Melbourne, Australia

More information

ESSoS12 - International Symposium on Engineering Secure Software and Systems NEW

February 16 - 17, 2012, Eindhoven, The Netherlands

More information

IEEE CogSIMA 2012 – 2nd International Conference on Cognitive Methods in Situation Awareness and Decision Support NEW

March 6 – 8, 2012, New Orleans, LA, USA

More information

CSER 2012 – Conference on Systems Engineering Research

March 19-22, 2012, St Louis, Missouri, USA
More information

The 9th ENTERPRISE ENGINEERING Track at ACM-SAC 2012 NEW

The 27th ACM Symposium on Applied Computing

25-29 March 2012, Riva del Garda, Trento, Italy

More information

Fifth Edition of the Requirements Engineering Track (RE-Track'12)

Part of the 27th ACM Symposium on Applied Computing (SAC 2012)

March 25-29, 2012, University of Trento, Trento, Italy

More information

Applied Ergonomics Conference 2012 NEW

March 26-29, 2012, Gaylord Opryland Resort and Convention Center, Nashville, Tenn, USA

More information

SETE APCOSE 2012

April 30 – May 2, 2012, Brisbane Convention and Exhibition Centre, Brisbane, QLD, Australia

More information

IIE Annual Conference and Expo 2012 NEW

May 19-23, 2012, Hilton Bonnet Creek, Orlando, Fla, USA

More information

12th INTERNATIONAL DESIGN CONFERENCE DESIGN 2012

21 - 25 May, 2012, Dubrovnik, Croatia
More information

Education and Academia

Georgia Institute of Technology

PSLM: Product & System Lifecycle Management Center

In Fall 2010 the PSLM Center was transformed into the Model-Based Systems Engineering (MBSE) Center consistent with the MBSE updated mission focus. The new website is being formed here: www.mbse.gatech.edu.

From 2004 to 2010 the Product & Systems Lifecycle Management Center (PSLM Center) was the Georgia Tech focal point for product lifecycle management (PLM) and systems of systems (SoS) research, education, and outreach.

More information

Penn State Systems Engineering (Master of Engineering)

One of the important fundamentals of systems engineering is that it isn't taught from a discipline-specific perspective, therefore it's not taught just for electrical engineers, mechanical engineers, industrial engineers, or aeronautical engineers; rather, it is meant to bring all of those disciplines together. So, systems engineers are people who have to have a big-picture view of engineering and are able to take those other disciplines and get them to work together.

More information

Systems Engineering and Management Degree Debuts

A new master's degree program at UT Dallas will prepare graduates to take leading roles in managing high-tech engineering projects.

The Systems Engineering and Management Program at the University's Erik Jonsson School of Engineering and Computer Science will teach students to apply scientific and management principles to the design, development and operation of complex projects that often involve large interdisciplinary teams working on tight deadlines toward ambitious goals.

More information

New way to teach students being highlighted in Tucson

The way students learn has changed over the decades. Educators constantly are looking for more effective ways to reach kids. And now one group thinks it's hit the jackpot. The technique has been highlighted at a conference in Tucson.

The purpose of the meeting at the Westin La Paloma was to inspire educators and students to think about learning in a new way. About 250 people attended from 7countries and 18 states to change what students learn and how they learn it.

Peter Senge is considered a world leader in organizational change. He says the way these folks teach, "You rarely see a teacher standing in front of a room giving a boring presentation. The kids are all working in groups. It's much more engaging. It's much more motivating."

The teaching technique is called "systems thinking."

More information

Some Systems Engineering-Relevant Websites

http://www.omg.org/ocsmp

The Object Management Group (OMG) - Certified Systems Modeling Professional™ (OCSMP™) Certification program awards four levels of certification, arranged in a single hierarchy, based on four multiple-choice examinations. Program details including the exact array of exams, their levels, names, and topical coverage have been determined by our committee of SysML domain experts, and the examinations are available from our test delivery company, Pearson VUE, in their worldwide network of testing centers.

http://wiki.developspace.net/Open_Source_Engineering_Tools

This is a DevelopSpace project to aid the space systems development by providing access to relevant, open source engineering software tools, using input provided by both DevelopSpace contributors and the wider space engineering community. We aim to both provide information on existing tools and identify areas in which new tools would be of use so as to encourage the development of such tools.

For tools that are available, our goal is to provide reviews regarding the usefulness of each tool for particular applications, guides on how to most effectively use the tools for various types of efforts related to space system development, and descriptions of how the tools can be used together. Where needs exist to either create new tools or enhance existing tools, we will aim to gather input regarding what functionality is desired and (when possible) point towards relevant commercial tools that could serve as models.

While the focus of this project is on tools that are relevant to space applications, space engineering has significant overlap with many other engineering disciplines, as such a significant number of the tools we describe will be relevant outside of the space arena.

Standards and Guides

ISO 31000 - Risk Management

ISO 31000:2009 sets out principles, a framework, and a process for the management of risk that are applicable to any type of organization in either the public or the private sector. It does not mandate a "one size fits all" approach, but rather emphasises the fact that the management of risk must be tailored to the specific needs and structure of the particular organization.

ISO 31000 is published by the Technical Management Board

Bringing Standards to the Burgeoning Cloud

By Kathy Kowalenko

As Apple, Amazon, Google, and other companies race to offer cloud-based systems for storage, synchronization, and all sorts of applications, they're encountering several pitfalls along the way. The not-unexpected hurdles include a plethora of file formats, applications that fail to operate with each other, and the inability to move data from one cloud-service vendor to another.

To help resolve such problems, IEEE has launched the Cloud Computing Initiative, the first broad-based project for the cloud to be introduced by a global professional association. It includes the sponsoring of standards, conferences, publications, and educational activities. At the start, a pair of new standards development working groups is focusing on two things: writing a cloud portability roadmap and producing an interoperability standard. The IEEE Computer Society is sponsoring both efforts.

More information

A Definition to Close on

Petri Net

Petri Net: An abstract, formal model of information flow, which is used as a graphical language for modeling systems with interacting concurrent components; in mathematical terms, a structure with four parts or components: a finite set of places, a finite set of transitions, an input function, and an output function.
Source: http://www.answers.com/topic/petri-net

Petri Net: A Petri net (also known as a place/transition net or P/T net) is one of several mathematical modeling languages for the description of distributed systems. A Petri net is a directed bipartite graph, in which the nodes represent transitions (i.e. events that may occur, signified by bars) and places (i.e. conditions, signified by circles). The directed arcs describe which places are pre- and/or postconditions for which transitions (signified by arrows). Some sources state that Petri nets were invented in August 1939 by Carl Adam Petri – at the age of 13 – for the purpose of describing chemical processes.
Like industry standards such as UML activity diagrams, BPMN and EPCs, Petri nets offer a graphical notation for stepwise processes that include choice, iteration, and concurrent execution. Unlike these standards, Petri nets have an exact mathematical definition of their execution semantics, with a well-developed mathematical theory for process analysis.
Source: http://en.wikipedia.org/wiki/Petri_net

Petri Net: Petri nets, or place-transition nets, are classical models of concurrency, non-determinism, and control flow, first proposed by Carl Adam Petri in 1962. Petri nets are bipartite graphs and provide an elegant and mathematically rigorous modelling framework for discrete event dynamically systems.
Source: Nick Chapman, Imperial College, London

Petri Net: A directed, bipartite graph in which nodes are either "places" (represented by circles) or "transitions" (represented by rectangles), invented by Carl Adam Petri. A Petri net is marked by placing "tokens" on places. When all the places with arcs to a transition (its input places) have a token, the transition "fires", removing a token from each input place and adding a token to each place pointed to by the transition (its output places). Petri nets are used to model concurrent systems, particularly network protocols. Variants on the basic idea include the coloured Petri Net, Time Petri Net, Timed Petri Net,
Stochastic Petri Net, and Predicate Transition Net.
Source: The Free, on-Line Dictionary of Computing

Petri Net: An abstract, formal model of information flow, which is used as a graphical language for modeling systems with interacting concurrent components; in mathematical terms, a structure with four parts or components: a finite set of places, a finite set of transitions, an input function, and an output function.
Source: McGraw-Hill Dictionary of Scientific & Technical Terms

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PPI Events

Systems Engineering Public 5-Day Courses (2011)

Upcoming locations include:

- Adelaide, Australia
- Brisbane, Australia
- Melbourne, Australia
- Amsterdam, The Netherlands
- Munich, Germany

Requirements Analysis and Specification Writing Public Courses (2011)

Upcoming locations include:

- Stellenbosch, South Africa
- Las Vegas, USA
- Amsterdam, The Netherlands
- Adelaide, Australia
- Pretoria, Australia

Software Development Principles & Processes Public 5-Day Courses (2011)

Upcoming locations include:

- Sydney, Australia

OCD/CONOPS Public Courses (2011)

Upcoming locations include:

- Brasilia, Brazil

Cognitive Systems Engineering Courses (2011)

Upcoming locations include:

- Adelaide, Australia
- Pretoria, South Africa
- Las Vegas, USA
- Sydney, Australia

PPI Upcoming Participation in Professional Conferences

- ISEM 2011 (Exhibiting) – Stellenbosch, South Africa 21 – 23 September 2011
- NZDIA 2011 (Exhibiting) – Wellington, New Zealand 15 – 16 November 2011

Kind regards from the SyEN team:

Robert Halligan, **Managing Editor**, email: rhalligan@ppi-int.com
Alwyn Smit, Editor (retiring), email: asmit@ppi-int.com
Ralph Young, Editor (Designate), email: ralph.young1943@gmail.com
Elise Matthews, Production, email: ematthews@ppi-int.com

Project Performance International

2 Parkgate Drive, Ringwood, Vic 3004 Australia
Tel: +61 3 9876 7345
Fax: +61 3 9876 2664
Tel Brasil: +55 12 3212 2017
Tel UK: +44 20 3286 1995
Tel USA: +1 888 772 5174
Web: www.ppi-int.com
Email: contact@ppi-int.com

Tell us what you think of SyEN: email to contact@ppi-int.com