

Randall Russell. *Systems Engineering in Practice: Complexity Emerges in a Successful Company in a Mature Industry*

Systems Engineering is not just Defense Aerospace anymore. Many successful companies in mature industries face the daunting challenge of initiating a Systems Engineering program to remain competitive or regain their competitive edge. Some of those companies have a history of Systems Engineering efforts which lost momentum, and failed to achieve the goals. There are some simple, practical principles for a (re)startup Systems Engineering initiative which have provided traction and garnered positive responses in the otherwise skeptical and resistant organization: pragmatic simplicity, ...

William Schindel. *The Agile Systems Pattern: A Reference Model for Agility in Systems*

Human-engineered and other systems may be under pressure to adapt--whether they encounter new opportunities or are threatened by commercial competition, living predators or ecological competitors, physical military attack, or cyber threat, or other changes in their environment. The ongoing ability of individual systems or system families to adapt well enough as conditions change, especially in the presence of uncertainty about future conditions, is a highly-valued capability that may determine prosperity, lifespan, or survival. Systems (including developmental and other life cycle systems) ...

William Schindel. *Got Phenomena? Science-Based Disciplines for Emerging Systems Challenges*

Specialists in individual engineering disciplines (ME, EE, CE, ChE, etc.) sometimes argue their fields have “real physical phenomena”, physical laws based in the “hard sciences”, and first principles, often claiming that Systems Engineering lacks the equivalent phenomena foundation. This talk will explain why the opposite is true, and how “re-planting” systems engineering in MBSE / PBSE supports the emergence of new hard science phenomena-based domain disciplines. This approach defines a System as a set of interacting components. When behaviors of isolated individual ...

C. Robert Kenley and Nathan Hartman. *Sustaining Systems Engineering: The Critical Role of Product Lifecycle Management*

To address many of the challenges that system engineering faces, systems engineers must cope with detail-oriented activities that typically occur during the design, integration, assembly, and test of systems. Advances in computational capabilities enable virtual system prototypes that use highly detailed representations of a system’s components that provide a means for performing the virtual integration, assembly, and test of systems and for composing custom designs of systems and systems of systems. We describe the critical role of product lifecycle management in increasing the actual and ...

Bret Rudnick. *Ensuring Reliability of Future Mars Probes*

Since humans first achieved the technology to attempt to explore Mars, more than half of all attempts have failed. Experience and lessons learned have created some notable successes (e.g.,

Spirit and Opportunity), but there have been some notable failures as well (e.g., Beagle 2 and Mars Climate Orbiter). To date, there have been no attempts to return surface samples to earth, and one such attempt from the Mars moon Phobos failed. Are there any notable factors in the building of these probes that might assist future efforts to succeed? Are there common factors in design, testing, mission ...

Michael Vinarcik. *SKETCHING WITH SYSML: PROPER*

FRAMING OF PROBLEMS LEADS TO INNOVATIVE SOLUTIONS

The proper framing of problems has a significant impact on the solutions generated to solve them. Studies have shown that individuals presented with alternatives tend to assume that the presented set of solutions is complete; this can lead to groupthink and insufficient exploration of a given problem's solution space. This issue becomes particularly acute in mature industries such as defense, automotive, and durable goods. The author believes that associative thinking is a key attribute of innovators and that this skill can be further developed by fostering the formation of heuristics. ...

Michael Vinarcik. *RICHER FUNCTIONAL DECOMPOSITION: USING OPERATIONS AND METHODS IN SYSML*

Traditional functional decomposition relies upon a hierarchical decomposition of functions into a tree of subfunctions. While this method and technique can be useful, the emergence of Model-Based Systems Engineering (MBSE) and SysML enables the creation of a richer expression of system behavior. This presentation will describe techniques that can be used to express system behaviors in terms of use cases, activity diagrams, and operations. It will emphasize that even while maintaining solution neutrality, a behavioral representation can be matured with subject matter expert (SME) input. ...

Christopher Hoffman and William D. Schindell. *Systems Engineering Community of Practice Social Network Pattern*

As organizations grow, the ratio of specialists to users in a product development environment may approach levels that challenge a business to remain capable. Competency models for individual assessment and company-wide organizational assessments (such as CMMI-DEV) aid in measuring the individual and organization for improvement activities. However, the manner in which the business and domain specialists should organize to best support these improvement efforts may be ad-hoc or domain specific. This presentation reports on an application of Pattern-Based Systems Engineering (PBSE) to ...

Courtney Wright. *INCOSE Certification: A Tool for Getting Your Next Job*

Whether you're looking for a different assignment with your current employer or a job in a different industry, the INCOSE Certification Program is a tool that can help. Completing the INCOSE Certification Process at the ASEP, CSEP, or ESEP level requires you to demonstrate your knowledge, experience, and leadership in systems engineering. The Certification notes that INCOSE has verified these characteristics. The same things – SE knowledge, experience, and

leadership – are also appealing to employers, and going through INCOSE’s process will make you better at presenting your ...

Apoorv Maheshwari, Michelle Lott, Robert J. Malins, Christophe Waterplas, Jack Stein, Ajay Thukral, C. Robert Kenley and Daniel A. Delaurentis. *Application of Systems Engineering to Regulatory Compliance Activities for Medical Devices*

The INCOSE Biomedical-Healthcare Model-Based Systems Engineering (MBSE) Challenge Team has developed a reference model that uses SysML to represent a generic infusion pump and a systems engineering process for planning, developing, and obtaining regulatory approval of a medical device. This presentation describes recent updates to the model that incorporates Buede’s textbook model for the engineering design of a system and harmonizes it with ISO 15288 and applicable medical device industry standards such as ISO 14971 Application of Risk Management to Medical Devices and IEC 62366-1 ...

Robert Malins and Chris Unger. *Model-Based Systems Engineering to Integrate On-Going Healthcare Simulations: A Value Proposition Discussion Paper*

At the INCOSE IW2015 the Healthcare Working Group (HWG) hosted a workshop to take the first steps towards understanding the value proposition of model-based systems engineering (MBSE) for improving the safety, effectiveness and efficiency of healthcare. A key outcome of the workshop was for the HWG to define the relationship between MBSE and other healthcare modeling and simulation (M&S) in order to determine how MBSE practitioners can augment the efforts of the healthcare simulation community. The purpose of this paper is to present the HWG’s draft framework for integrating on-going ...

Edmond Ramly and Kendra Kreutz. *Implementing Complex Interventions in Health Care: Sustainability of What?*

This presentation addresses how implementations of complex behavior change interventions are made more sustainable and resilient to cyber-social factors by using the Work System Model from Macroergonomics. The Work System Model presents five elements (human, organization, tools/technologies, processes/tasks and physical environment) and supports the analysis of how these components work together as the system undergoes change. This framework supports the system engineer to design requirements, evaluate the connections between elements and understand how the context plays a role in each ...

David Walden. *Back to Basics – The Lines are just as Important as the Boxes*

“Relationships among the elements are what give systems their added value” Eberhardt Rechtin In most systems and projects, the “boxes” have well-defined owners who are responsible for them. The “lines” between the boxes often times do not have as clear of ownership. The emergent properties that result from the interactions of the boxes are usually even less defined and understood. This paper explores how we, as systems engineers, need to step-up and take ownership of the lines. These lines can take many forms. For a system, the lines represent the functional and physical ...

David Walden. *Tutorial – INCOSE SE Handbook Overview*

The objective of this one-day tutorial is to provide a top-level overview of the Fourth Edition of the INCOSE Systems Engineering Handbook (SEH) that was released in 2015. Participants will learn how the handbook can be used to plan, manage, and realize complex systems within the context of demanding business constraints. Participants are introduced to key Systems Engineering terminology, concepts, and principles in the handbook, answering questions such as:

- What is Systems Engineering and why is it important?
- Why is the INCOSE SEH relevant to you and your organization?
- What ...

Matthew Hause. *Using Model-based Product Line Engineering as a Decision Framework*

Product Line Engineering (PLE) is the engineering and management of a group of related products using a shared set of assets as a means design and manufacturing. Typically, manufacturers create a single product for a specific purpose or customer. Variations of the product would be created when customers' needs changed or to improve production. Eventually, these would evolve into product lines. However, creating the product lines after the fact takes of time, money and effort to achieve the return on investment. A different approach needs to be taken. Like systems engineering, PLE involves ...

Brian Merchant and David Cook. *Unlocking Model Based System Engineering through the use of patterns*

Many organizations are often reliant on a small set of subject matter experts to ensure the success of system development efforts resulting in significant inefficiencies in the engineering organization. Introducing robust model-based systems engineering (MBSE) patterns into the development process allows the organization to embed its core knowledge into an easily usable and distributable form. Having this knowledge in an easily usable form enables organizational learning, greatly reduces program risks and minimizes many repetitive development tasks. The MBSE patterns include all aspects ...

Vijay Thukral, Bill Schindel and Ajay Thukral. *Application of PBSE to improvement of EMR in medical practice*

Modern Electronic Medical Record (EMR) systems serve as a central data repository for patient data, providing interfaces for data entry, to search and view patient past records, and for current updates and treatment plans at any time and any place. EMR has been touted as the most promising tool for improving the delivery of quality health care by improving the productivity, safety and efficiency of the health delivery system. EMR workflow can include data exchange protocols to facilitate patient data exchange with other health systems and organizations. EMR saw an accelerated adoption ...

Ajay Thukral. *Case Study: Application of MBSE methods for Hospital Emergency Departments*

The INCOSE Healthcare Working Group (HWG) has lead several initiatives regarding the need for systems engineering approaches to address health care delivery. The initiatives have engaged the systems community and the healthcare community to capture the needs of the healthcare from the healthcare community and simultaneously educate and share the systems methodologies and system tools. One of the recommendations of such initiative is to demonstrate the application of system engineering approach and methodology to a specific healthcare delivery problem. Based on the recommendation HWG MBSE ...

Chris Orłowski, Paul Blessner, Timothy Blackburn and Bill Olson. *A Framework for Implementing Systems Engineering Leading Indicators for Technical Reviews and Audits*

This paper proposes a framework for implementing systems engineering measures at technical reviews and audits that expand upon the International Council on Systems Engineering (INCOSE) set of systems engineering leading indicators. Premature transition through key decision gates is likely to lead to cost and schedule overruns. Risks to a program can be monitored by measuring key systems engineering measures in the development of products. Decision makers need to assess uncertainty in a program's ability to meet cost, schedule and technical performance requirements at key milestones ...

Jason Sherey. *Systems Engineering Pop Art*

Model-Based Systems Engineering (MBSE) is often promoted as way to create a more consistent and clearer understanding of the requirements and design of a system. The various modeling languages and methods offer the capability to model details at ever-deepening levels. Recent software modeling tools with their exciting features not only enable but encourage such modeling. The instant gratification to make a detailed model and query and present information based on that model can lead to an insatiable thirst for more detail and a more perfect model. The dichotomy of a perfect image of an ...

Troy Peterson. *Dynamic Visualization of Complex Systems: Extending the Impact of Model Based Systems Engineering*

As today's cyber physical systems become more and more complex they provide both incredible opportunities and risks. In fact, rapidly growing complexity is a significant impediment to the successful development, integration, and innovation of systems. Over the years, methods to reduce system complexity have taken many forms. Model Based Systems Engineering (MBSE) provides organizations a timely opportunity to address this complexity. MBSE tools, languages and methods are still in a formative stage and continue to evolve. The Systems Modeling Language (SysML) has proven to be a ...

Richard Winslow. *The NIST Risk Management Framework in 30 Minutes*

All information systems that are even remotely associated with the US government are now subject to the NIST Risk Management Framework process. The NIST RMF replaces the legacy Orange Book, NISPOM, DITSCAP, FISMA, and DIACAP processes (among others). The benefits of having a single standard security process are huge, but the massive size of the NIST

documents can make the process seem overwhelming. Also, the selection and management of the resulting 800 to 1000 security controls can be a daunting task. This presentation introduces the six steps of the Risk Management Framework process: ...

David Flanigan and Jeffery Dixon. *Smart City Critical Infrastructure Resiliency Assessment*

Existing Critical Infrastructure (CI) is performed by analysis of mainly the "lifeline" CI sectors, such as electricity, water, communications, and transportation. These are well-studied and are tangible to quantify and model. The Department of Homeland Security lists 16 CI sectors, many of which are not modeled, but equally important to the conduct of both public and private business. A methodology is proposed to map the under-served CI sectors in a way to visualize the interdependency between sectors, as well as measure the input and output sectors, both in normal and reduced ...

Becky Reed. *Risk and Architecture*

System development activities provide an ideal opportunity for identifying risks that could impact the system (and the project) throughout the life cycle. Early development phases such as conceptual architecture definition and high-level functional analysis can provide the opportunity for identification of potential risk areas that can impact system interfaces and future operational expectations. Architectural synthesis can present possible threats to successful system integration and implementation. All of these risks must be assessed and managed to prevent or reduce costly impacts at all ...

Don Gelosh. *A Systems Thinking Approach to Developing Learning Outcomes for Systems Security Engineering*

There is a general consensus that the various activities that support Systems Security Engineering (SSE) fall squarely under Systems Engineering. However, while we don't expect all Systems Engineers to be SSE experts, we do expect them to be aware of and appreciate the importance of developing secure and trusted systems and networks. In some cases, a Systems Engineer may choose to become an expert in some area of SSE and that's fine. Of course, we can provide this awareness, appreciation and even advanced expertise through education, training and experience. The biggest challenge is ...

Logan Mailloux, Michael Grimaila, Douglas Hodson, John Colombi and Ryan Engle. *Modeling Complex Cyber Security Systems*

Quantum Key Distribution (QKD) is a complex cyber security technology which exploits the laws of quantum physics to generate and distribute shared cryptographic key in support of secure communications. QKD offers the advantage of unconditionally secure key generation with the unique ability to detect eavesdropping on the key distribution channel. These behaviors show promise for high-security applications such as critical information systems found in banking, government, and military environments. However, QKD is a nascent technology where practical engineering limitations and implementation ...

Parth Shah, James Behmer, Kolawole Ogunsina and Suhas Srinivasan. *An Agent-Based Modeling Approach to creating More Resilient Littoral Combat Architectures*

Littoral combat is a critical component of naval warfare that has gained importance since the late 20th century due to a shift from matched blue-water combat to agile, asymmetric warfare near the coast. With the increased relevance of such this type of naval combat, the ability of a networked naval warfare System-of-Systems (SoS) to operate effectively given the challenges of operations in the littoral zone becomes imperative. Resilience in a SoS in the face of a variety of threats is vital. These threats may take various forms: traditional warfare, cyber attacks, or communications ...

Sean Beckman and Scott Darpel. *Using Systems Engineering modeling tools to facilitate earlier identification of safety, and mission/quality assurance requirement*

During the early development of products, flight, or experimental hardware, emphasis is often given to the identification of technical requirements, utilizing such tools as use case and activity diagrams. Designers and project teams focus on understanding physical and performance demands and challenges. It is typically only later, during the evaluation of preliminary designs that a first pass, if performed, is made to determine the process, safety, and mission/quality assurance requirements. Evaluation early in the life cycle, though, can yield requirements that force a fundamental change in ...

Matthew Hause. *Making Smart Cities Smarter – MBSE Driven IoT*

The Internet of Things (IoT) is a system of systems in every sense of the definition. A.P. Sage and others list five common characteristics: operational independence of the individual systems, managerial independence, geographical distribution, emergent behavior and evolutionary development or independent life cycles. Typical examples include smart houses, the electric grid, complex military systems and so-called smart cities. The future of IoT success, including technology advancements and revenue generating potential across the business spectrum, is dependent on the application of solid ...

Matthew Hause. *An Examination of Interoperability in Systems Development Using DoDAF*

Interoperability is a concept that most of us instinctively understand. The word itself implies the ability of two or more entities to interoperate or work together. The IEE defines Interoperability as the ability of making systems and organizations work together (inter-operate) for information technology or systems engineering services to allow for information exchange. At the Network Centric Operations Industry Consortium - NCOIC, 2012, T Slater stated a more broad definition that takes into account social, political, and organizational factors that impact system to system performance. A ...

Saulius Pavalkis. *Industrial Integration of MBSE into PLM for Mission Critical Systems*

MBSE is an evolving practice in the early stages of adoption similar to the mechanical and electrical engineering domains in the past century, and the software domain 20 to 30 years ago. Today there is increasing recognition of the potential MBSE brings to system engineering with

the increasing complexity of systems and the demands of the global marketplace. However industry adoption requires solving multiple problems. Most of them originates when MBSE is incorporated into industrial, product lifecycle management (PLM) toolchain for requirements, variability, and design management. In ...