GLRC9

Ninth Annual

INCOSE
Great Lakes Regional Conference

INCOSE 2015 TWENTY-FIFTH ANNIVERSARY

Crowne Plaza Cleveland South

Cleveland, Ohio

October 23-25, 2015

Ecosystem | Education | Health Care | Information | Manufacturing | Transportation

Welcome Message from the Cleveland-Northern Ohio Chapter President

On behalf of the Cleveland-Northern Ohio INCOSE Chapter, I welcome all conference participants to GLRC9!

The Conference Committee, comprised of members from five Great Lakes chapters, has worked diligently since September 2014, to deliver a useful and enjoyable conference experience. We believe that you will surely take away a better appreciation of cybersecurity and physical security. Respecting those two crucial elements, early in the Requirements Stage, can strongly enhance the resiliency of your systems.

We urge you to see some of Cleveland's most amazing facilities. Sign up for the Cleveland Clinic Tour to witness state-of-the-art physical and cybersecurity measures at their Data Center, and learn about advanced systems engineering deployed in the Emergency Department and the Ebola Assessment Center.

For a fun time in Cleveland, and to build stronger ties with other systems engineers working in the Great Lakes Region, do take advantage of dining in Little Italy, Friday evening. Don't miss our group outing to the Great Lakes Science Center on Saturday. Have a complimentary beer or glass of wine while touring the NASA Glenn Visitor Center, followed by dinner.

Finally, please take every opportunity to thank our Sponsors and Exhibitors. Without their generous support, we could not have staged such hospitality for GLRC9.

Sincerely,
Carl Dister

INCOSE
Cleveland-Northern Ohio Chapter

Acknowledgments

We are grateful for the time, effort, and expertise
contributed by everyone who participated in planning GLRC9.

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Venue Information

Conference Registration

The GLRC9 Registration Table is located in the hallway leading to the Skyline Ballroom. If you happen to stop by at a time when the table is unattended, look for a Conference Committee Member, identifiable by their colored namebadge. They will be happy to help!

Meals, Coffee, and Snacks

Breakfast

Registered GLRC9 Attendees are invited to a complimentary Continental Breakfast, served in the Skyline Ballroom, all three days of the conference. Friday and Saturday: 7:00 - 9:00 AM. Sunday: 7:00 - 8:30 AM.

Lunch

Sponsored, complimentary Lunches will be served Friday and Saturday, from noon to 1:00 PM, in the Skyline Ballroom.

Coffee Breaks

Mid-morning and mid-afternoon breaks are scheduled for Friday and Saturday. Come to the Exhibit Room (Salon 2 of the Cuyahoga Ballroom) for refreshment and lively networking. Meet the friendly representatives of our Sponsors and Exhibitors. Check out their products and services, and be sure to thank them for their generous support of GLRC9. Coffee will be available in Salon 2, all morning, on Sunday.

Local Restaurants

The Crowne Plaza's Aura Bistro and Lounge is just steps away, offering "contemporary global cuisine," late into the evening (10 PM).

Many casual and fine dining options are located within walking or nearby driving distance. Consult the list and map included in your GLRC9 Tote Bag.

Local Transportation

The Crowne Plaza offers a complimentary shuttle service (within four miles of the hotel).

Internet Access

Free Wi-Fi is available throughout the Crowne Plaza.

Business Center

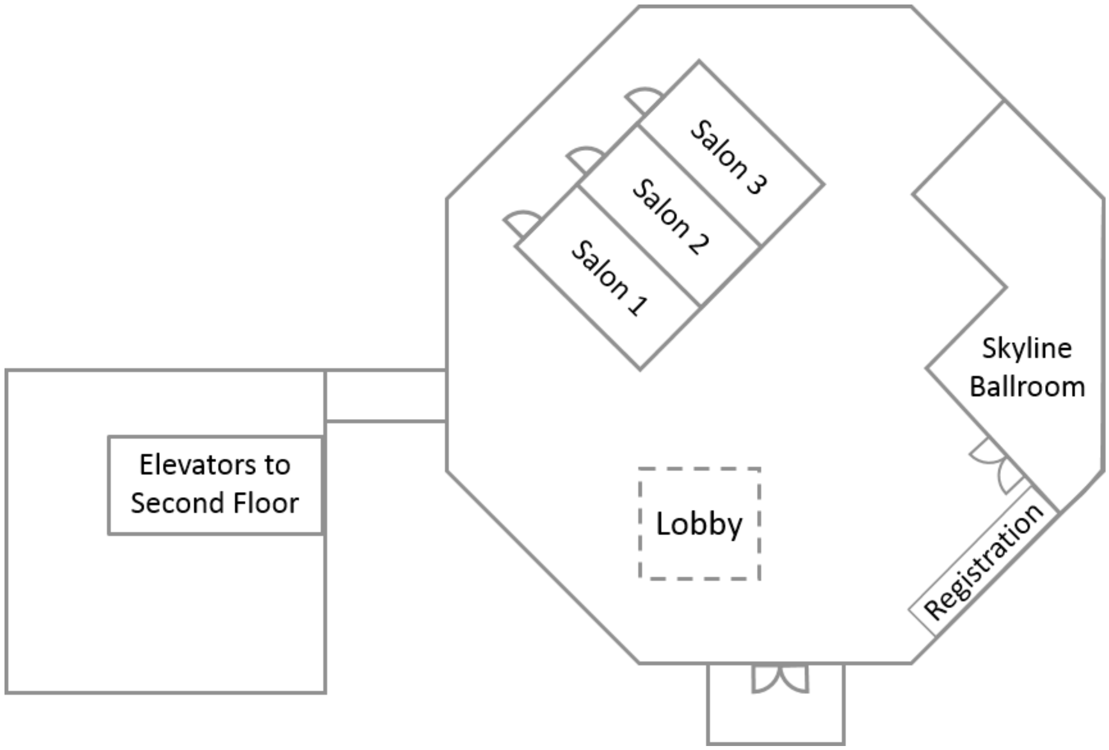
The Crowne Plaza Business Desk is open around the clock. Equipment includes a computer, copier, printer, and scanner. Standard office supplies are available.

Need help or have a question?

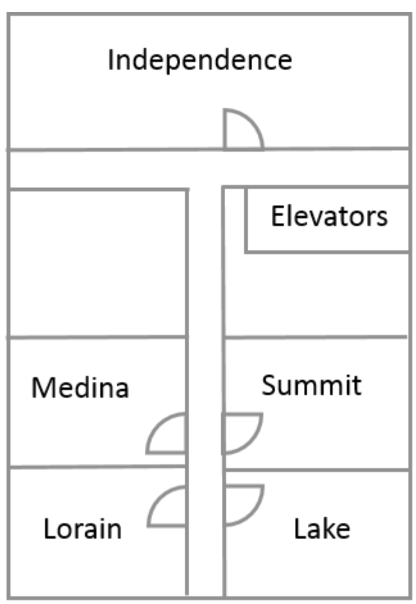
Seek out a Conference Committee Member! Just look for a colored namebadge.

Map of Conference Hotel

First Floor: Registration, Breakfast, Lunch, Sessions, Tutorials, and Exhibit Room



Second Floor: Certification Exam and Sessions



Keynote Speakers

Jack Stein is a Systems Engineer, Co-Chair of the INCOSE Risk Management WG, and member of the INCOSE-PMI Alliance WG. He also serves as Assistant Director of the INCOSE Americas Sector North-Central Region. Mr. Stein has 28 years of experience in the Automotive and Medical Device industries, and more than 20 years of experience as a U.S. national technical expert in the development of numerous standards (ISO, IEC, SAE, ZVEI). He recently completed the revision the Risk Management section of the INCOSE S.E. Handbook (for version 4.0), and is heading a collaboration between the INCOSE Risk Management WG and the Project Management Institute (PMI) Risk Management Community of Practice (CoP) in support of the INCOSE-PMI Strategic Alliance.

David Long - For over twenty years, David Long has focused on enabling, applying, and advancing model-based systems engineering (MBSE) to help transform the state of the systems engineering practice. David is the founder and president of Vitech Corporation where he developed CORE®, a leading systems engineering software environment. He co-authored the book A Primer for Model-Based Systems Engineering and is a frequent presenter at industry events around the world. A committed member of the systems community, David is the president of the International Council on Systems Engineering (INCOSE.)

INCOSE
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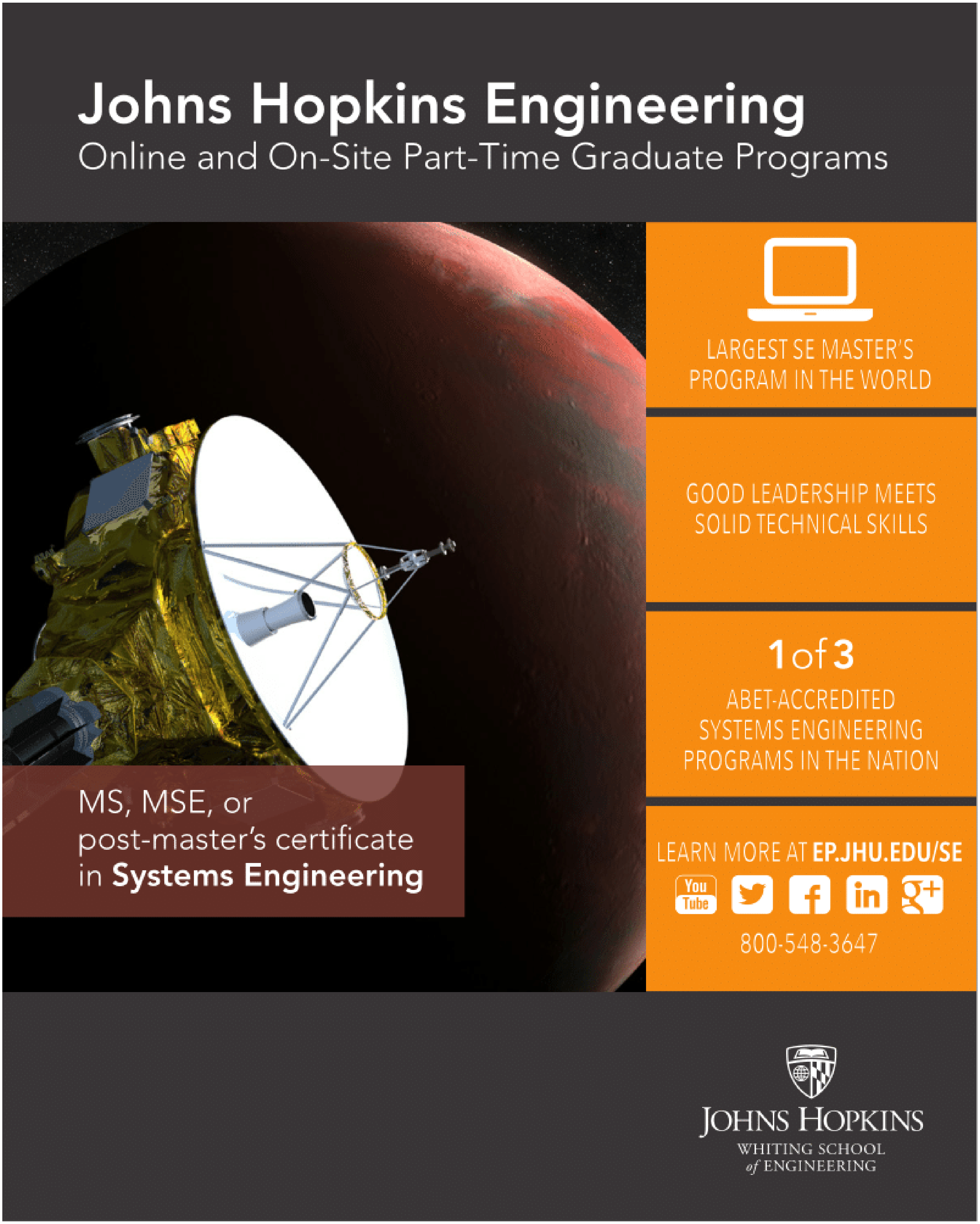
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Cleveland Clinic Tour

This tour is restricted to those who prepaid $35 for the tour (via RegOnline) and to any GLRC9 Attendees who pay $35 onsite, during the conference. See Marian Cronin to sign up and pay, before 1:45 PM on Friday.

Overview

Cleveland Clinic is a nonprofit, multispecialty academic medical center that integrates clinical and hospital care with research and education.

U.S. News & World Report consistently names Cleveland Clinic as one of the nation's best hospitals in its annual "America's Best Hospitals" survey. The Cleveland Clinic heart and heart surgery program has been ranked No. 1 in the nation since 1995.

The GLRC9 Conference Team has arranged a custom-guided tour of three Cleveland Clinic facilities: **Data Center, Emergency Department, and the Ebola Treatment Center**.

Transportation Details

Time	Event Description
2:00 PM	*Board van at 2:00 and travel from hotel to Location 1*
2:30 - 3:30 PM	**Location 1:** **Data Center - Groups A and B**
3:30 PM	*Board van at 3:30 and travel from Location 1 to Location 2*
4:15 - 5:00 PM	**Location 2:** **Group A - Emergency Department** **Group B - Ebola Assessment Center**
5:00 PM	*Short walk, to swap tours*
5:15 - 6:00 PM	**Location 2:** **Group B - Emergency Department** **Group A - Ebola Assessment Center**
6:00 PM	*Board van at 6:00 and travel from Location 2 to Little Italy*
6:30 - 8:45 PM	**DINNER** **at your choice of several Little Italy restaurants**
8:45 PM	*Board van at 8:45 to Crowne Plaza*
9:15 PM	*Van arrives at Crowne Plaza*

Great Lakes Science Center

The Conference Committee invites all GLRC9 attendees to join us for a fun-filled evening at the Great Lakes Science Center!

Transportation

Conference attendees will be transported by bus from the conference hotel to the Great Lakes Science Center. We encourage everyone to board the bus at 5:00 PM. If the bus fills completely, it will return to the main entrance of the hotel, to pick up the remaining attendees at 6:00 PM.

After dinner at the Science Center, board the bus at 8:45 PM, to return to the Crowne Plaza Hotel.

Reception and Tour

The social event begins at 5:30 PM, with a beer and wine reception in the NASA Glenn Visitor Center. Light appetizers will also be served.

Each attendee is welcome to select one free alcoholic beverage, courtesy of Reed Integration, Inc. You may purchase additional drinks, during the reception. Enjoy a *Dortmunder Gold Lager* or a seasonal *Oktoberfest*—both brewed by Cleveland's perennial award-winning Great Lakes Brewing Company.

Explore the entirety of the NASA Glenn Visitor Center, network with colleagues, and make new acquaintances!

Dinner Menu

A buffet dinner will be served at 7:00 PM, together with coffee, water, and unsweetened iced tea. If you wish to have beer or wine with dinner, feel free to carry a beverage from the Reception Area. (Bar service will close at 7:00 PM.)

Salads

Cous Cous Salad with Dried Apricots, Raisins, Hazelnuts and Feta Cheese

Spinach Salad with Oranges, Candied Pecans, Shaved Parmesan Cheese and Shallot Vinaigrette

Entrees

Applewood Smoked Bacon Wrapped Chicken, Fresh Sage, Roasted Tomato Au Jus

Sweet Thai Chili Glazed Salmon

Bell Peppers Stuffed with Three Cheese Risotto, Red Pepper Cream (vegetarian)

Sides

Roasted Fingerling Potatoes

Green Beans with Caramelized Shallots and Almonds

Dessert

Assorted Miniature Pastries

The Reception and Dinner are generously sponsored by REED INTEGRATION, INC.

Presentation Code Key

Track	Code
Systems	S
Cybersecurity	C
Healthcare	H
Combination	O

Presentation Abstracts for Friday

C1: A Systems Thinking Approach to Developing Learning Outcomes for Systems Security Engineering

Don Gelosh

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 determining the right level of knowledge, skills and abilities to provide the right level of awareness, appreciation, and advanced expertise. One approach is to use Systems Thinking. This presentation will explore how we used Systems Thinking to develop learning outcomes for the various SSE activities such as Program Protection Planning, Supply Chain Risk Management, Cybersecurity, Operations Security, Software Assurance and Anti-Tamper. We will show how this holistic approach and systems perspective enabled us to explore how all the components of the dynamic and complex discipline of SSE fit together and interact so we could develop learning outcomes that made sense overall and provided both efficiency and effectiveness.

C2: Risk and Architecture

Becky Reed

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 levels from system to project to enterprise. This presentation provides a brief overview of basic system architectural development processes and describes the risk areas that should be identified and managed during those process activities.

The target audience for this presentation includes Systems Engineers, Technical Managers, System Architects, Risk Managers, Interface Control Engineers, Project Managers, and Team Leads.

H1: Application of Systems Engineering to Regulatory Compliance Activities for Medical Devices

Apoorv Maheshwari, Michelle Lott, Robert J. Malins, Christophe Waterplas, Jack Stein, Ajay Thukral, C. Robert Kenley and Daniel A. Delaurentis

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 Application of Usability Engineering to Medical Devices. The model provides a clear roadmap that biomedical device developers can follow to integrate systems engineering activities with regulatory compliance activities to provide a more cohesive approach to developing effective and safe medical devices.

Presentation Abstracts for Friday

S1: Dynamic Visualization of Complex Systems: Extending the Impact of Model Based Systems Engineering

Troy Peterson

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 significant enabler to advance MBSE methods given its flexibility and expressiveness. The flexibility of the language and advances in tools also permits easy construction of allocation tables and dynamic tabular representations. While these strengths provide clarity and consistency unfortunately the number of people who know and can read SysML well is a relatively small group. This has led to some criticism and has limited widespread acceptance. To bring the full power of MBSE to the larger community system models represented in SysML can be represented in a more intuitive form for the larger community without sacrificing the power and expressivity of SysML's semantics. More specifically JavaScript libraries for providing dynamic interactive visualizations can provide the larger community insights into these powerful system models. These representations can help teams gain insights, build intuition and ultimately help speed the innovation process. This briefing will share how the translation of SysML models into Data-Driven Documents (D3.js or D3) provides a rich representation and understanding of system models previously only provided to limited set system modelers. An example of a system model within a well-known MBSE tool will be translated into D3 graph, matrices and dendrogram/tree representations. These views can provide teams a simple yet powerful means to analyze and manage complex systems. More specifically, they enable the larger community visualize, and analyze the key relationships represented in system models.

C3: Modeling Complex Cyber Security Systems

Logan Mailloux, Michael Grimaila, Douglas Hodson, John Colombi and Ryan Engle

Quantum Key Distribution (QKD) is a complex cybersecurity 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 non-idealities impact system performance and security. In this presentation, we described an efficient approach to develop QKD system-level models to enable the study of real-world QKD systems. Specifically, we detail the definition, implementation, and verification of a decoy state enabled QKD system model, and conduct a photon number splitting attack against said model. This research represents a multidisciplinary effort requiring expertise from quantum physics, optical communication engineering, electrical/computer engineering, software engineering, model and simulation, and information security.

H2: Model-Based Systems Engineering to Integrate On-Going Healthcare Simulations: A Value Proposition Discussion Paper

Robert Malins and Chris Unger

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 efforts to apply operations research methods (including lean techniques and physical simulations) and computer simulations (including discrete event simulations, stochastic simulations, etc.). The objective in presenting the concept is to gather input from a broad range of systems engineers in order to improve the value proposition for MBSE in healthcare. The outcomes of the discussion will become key input to the planning for the healthcare sessions at IW2016.

We propose that MBSE can benefit the healthcare simulation community by providing:

a) A methodology to standardize the representation of key healthcare processes;

b) A technique to capture the "bigger picture" context for understanding fully the significance of M&S results; and

Friday, October 23

Time Block	Cuyahoga Ballroom Salon 1	Independence Room	Cuyahoga Ballroom Salon 3	Medina Room
	Systems Chair: Stephen Lewis	**Cybersecurity** Chair: Thomas Lockhart	**Healthcare** Chair: Ammon Wright	**Certification** Chair: Courtney Wright
7:00 – 9:00 AM	**Registration** in hallway leading to the Skyline Ballroom **Breakfast** in Skyline Ballroom *sponsored by ICTT System Sciences* **Keynote Speaker** Jack Stein (8:00 AM)			
9:00 – 10:00 AM	C1: A Systems Thinking Approach to Developing Learning Outcomes for Systems Security Engineering Don Gelosh	C2: Risk and Architecture Becky Reed	H1: Application of Systems Engineering to Regulatory Compliance Activities for Medical Devices Apoorv Maheshwari, Michelle Lott, Robert J. Malins, Christophe Waterplas, Jack Stein, Ajay Thukral, C. Robert Kenley and Daniel A. Delaurentis	INCOSE Certification Exam
10:00 – 10:30 AM	**Coffee Break** in Exhibit Room (Salon 2)			
10:30 – 11:30 AM	S1: Dynamic Visualization of Complex Systems: Extending the Impact of Model Based Systems Engineering Troy Peterson	C3: Modeling Complex Cyber Security Systems Logan Mailloux, Michael Grimaila, Douglas Hodson, John Colombi and Ryan Engle	H2: Model-Based Systems Engineering to Integrate On-Going Healthcare Simulations: A Value Proposition Discussion Paper Robert Malins and Chris Unger	
11:30 AM – 12:00 PM	*Networking Buffer*			
12:00 – 1:00 PM	**Lunch** in Skyline Ballroom *sponsored by Jama Software*			
1:15 – 2:00 PM	C4: Smart City Critical Infrastructure Resiliency Assessment David Flanigan and Jeffery Dixon	C5: The NIST Risk Management Framework in 30 Minutes Richard Winslow	H3: Implementing Complex Interventions in Health Care: Sustainability of What? Edmond Ramly and Kendra Kreutz	
2:00 – 2:30 PM	**Coffee Break** Salon 2	**Cleveland Clinic Tour** (Pre-Registered Participants Only) *Board van at 2:00 PM* See Page 8 for Travel Details		
2:30 – 3:30 PM	S2: The Agile Systems Pattern: A Reference Model for Agility in Systems William Schindel			
3:30 – 4:00 PM	*Networking Buffer*			
4:00 – 4:45 PM	S3: Sustaining Systems Engineering: The Critical Role of Product Lifecycle Management C. Robert Kenley and Nathan Hartman			
5:00 – 9:00 PM	***SUMMIT BOARDROOM*** Model-Based Conceptual Design Working Group Michael Vinarcik			

Saturday, October 24

Time Block	Cuyahoga Ballroom Salon 1	Independence Room	Cuyahoga Ballroom Salon 3	Medina Room
	Systems **Chair: Stephen Lewis**	**Cybersecurity** **Chair: Thomas Lockhart**	**Healthcare** **Chair: Ammon Wright**	**Various**
7:00 – 9:00 AM	**Registration** in hallway leading to the Skyline Ballroom **Breakfast** in Skyline Ballroom *sponsored by Sysnovation, LLC*			
9:00 - 10:00 AM	S4: Ensuring Reliability of Future Mars Probes Bret Rudnick	C6: An Agent-Based Modeling Approach to creating More Resilient Littoral Combat Architectures Parth Shah, James Behmer, Kolawole Ogunsina and Suhas Srinivasan	H4: Case Study: Application of Model Based Systems Approach in Emergency Department Ajay Thukral	Tutorial T1: Understanding and Applying the INCOSE SE Handbook Fourth Edition David Walden
10:00 -10:30 AM	**Coffee Break** in Exhibit Room (Salon 2)			
10:30 – 11:30 AM	S5: Systems Engineering Community of Practice Social Network Pattern Christopher Hoffman and William D. Schindel	C7: Using Systems Engineering modeling tools to facilitate earlier identification of safety, and mission/quality assurance requirement Sean Beckman and Scott Darpel	H5: Application of SE to utilization of EMR in physicians practice Vijay Thukral, Bill Schindel and Ajay Thukral	
11:30 AM– 12:00 PM	*Networking Buffer*			
12:00 – 1:00 PM	**Lunch** in Skyline Ballroom *sponsored by Vantage Partners, LLC*			
1:15 – 2:15 PM	S6: INCOSE Certification: A Tool for Getting Your Next Job Courtney Wright	C8: Making Smart Cities Smarter – MBSE Driven IoT Matthew Hause	O1:Sketching with SysML: Proper Framing of Problems Leads to Innovative Solutions Michael Vinarcik	S7: Back to Basics – The Lines are just as Important as the Boxes David Walden
2:15– 2:30 PM	*Networking Buffer*			
2:30 – 3:30 PM	S8: A Framework for Implementing Systems Engineering Leading Indicators for Technical Reviews and Audits Chris Orlowski, Paul Blessner, Timothy Blackburn and Bill Olson	C9: Industrial Integration of MBSE into PLM for Mission Critical Systems Saulius Pavalkis	O2: Using Model-based Product Line Engineering as a Decision Framework Matthew Hause	S9: Got Phenomena? Science-Based Disciplines for Emerging Systems Challenges William Schindel
3:30 – 4:00 PM	**Coffee Break** in Exhibit Room (Salon 2)			
4:00 – 4:45 PM	***LORAIN ROOM*** S10: Systems Engineering Pop Art Jason Sherey	C10: An Examination of Interoperability in Systems Development Using DoDAF Matthew Hause	***LAKE ROOM*** O3: Unlocking Model Based System Engineering through the use of patterns Brian Merchant and David Cook	O4: Richer Functional Decomposition: Using Operations and Methods in SysML Michael Vinarcik
5:00—9:00 PM	**GREAT LAKES SCIENCE CENTER** *Board bus at 5:00 PM or 6:00 PM* **NASA Glenn Visitor Center Tour with Reception, followed by Dinner** *Sponsored by Reed Integration, Inc.* **Keynote Speaker: David Long**			

Sunday, October 25		
Time Block	**Cuyahoga Ballroom Salon 1**	**Cuyahoga Ballroom Salon 3**
7:00 – 8:30 AM	**Breakfast and Tutorial Registration** Cuyahoga Ballroom, Salon 2 Coffee to be available all morning in Salon 2	
8:30 - 10:15 AM	Tutorial T2: Purdue Peer Review Feedback Workshop	Tutorial T4: MBSE: Model Lifecycle Management Saulius Pavalkis
10:15 -10:30 AM	Break	
10:30 AM– 12:15 PM	Tutorial T3: Purdue Peer Review Feedback Workshop (reprised)	
12:15—12:30 PM		

Tutorial Abstracts

T1: Tutorial – INCOSE SE Handbook Overview

David Walden

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 are the key Systems Engineering processes in the SEH?
- How can you use the material in the SEH to make a difference on your projects?

Note: this tutorial is a one-day overview and does not include the level of detail typically presented in an INCOSE Systems Engineering Professional (SEP) preparation course.

T2 and T3: Purdue Peer Review Feedback Workshop

Purdue University Engineering Faculty Members

This Workshop is designed for:

- Experienced engineers who mentor/supervise employees
- Engineers who want to learn how to give practical and productive peer review on engineering design solutions

Workshop highlights include:

- Purdue Engineering Education researchers share their findings from a National Science Foundation funded project
- Opportunity to contribute to the Feedback on Design study

T4: MBSE: Model Lifecycle Management

Saulius Pavalkis

The focus for this tutorial is on NoMagic, Inc.'s experience and current best practices addressing model **configuration and change management**. The presentation provides a demonstration scenario to support exposing and exploring the significant challenges and issues facing Model Lifecycle Management (MLM). We use this scenario for further analysis and as the subject to show how particular solutions and latest technologies address various MLM issues.

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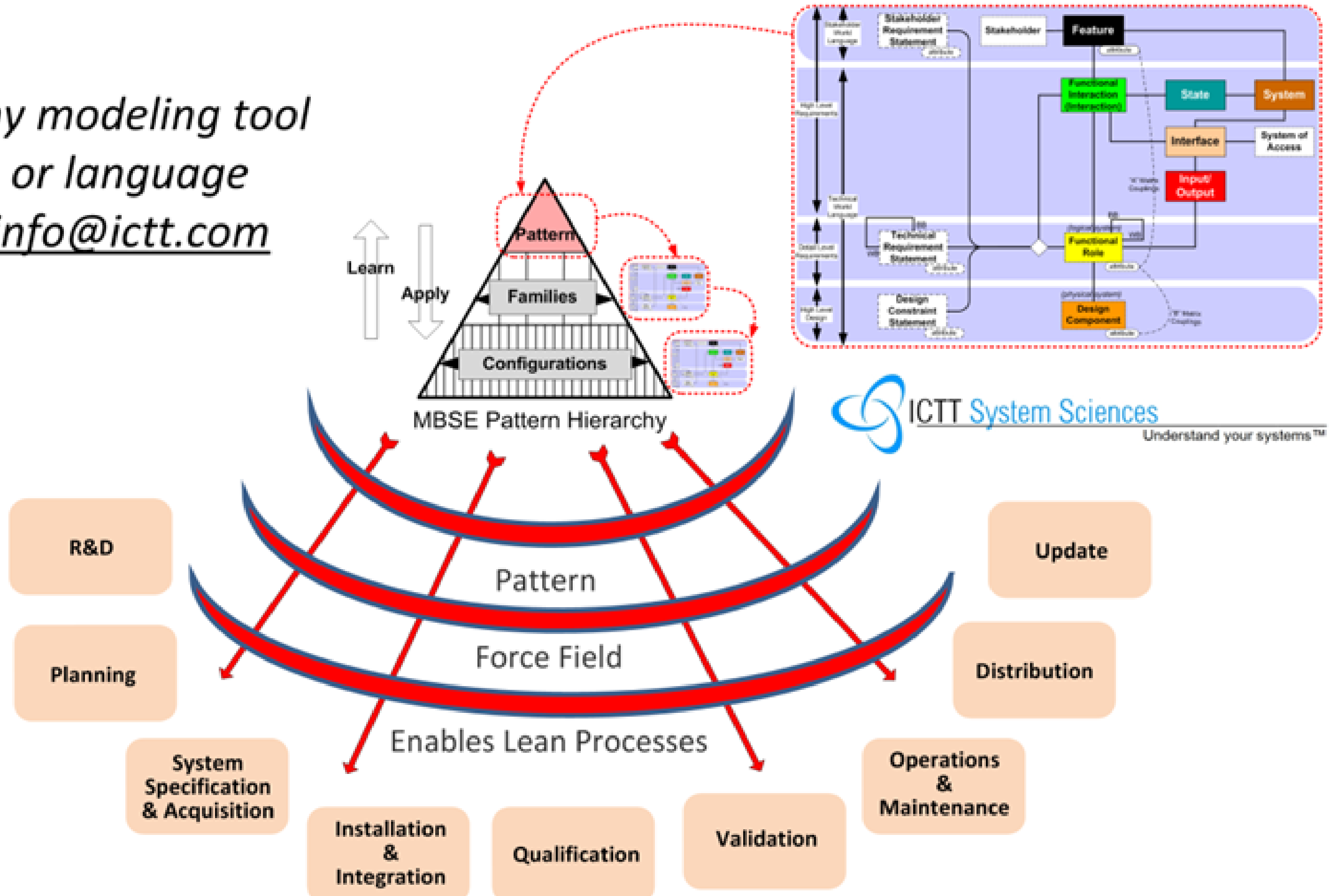

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c) A process for translating M&S studies into actionable requirements for the design and/or redesign of healthcare systems and workflows.

The paper will present an overview of the draft concept and lead the attendees in a discussion of the following questions: What are the techniques by which MBSE can integrate the broad range of ongoing healthcare simulation work?; How can MBSE add value to healthcare simulation?; How can MBSE translate the results of healthcare simulations into requirements for improving healthcare resilience?; What is the role for MBSE in addressing the increasing security and interoperability issues in healthcare?

C4: Smart City Critical Infrastructure Resiliency Assessment

David Flanigan and Jeffery Dixon

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 operations.

An example is used to evaluate the relationship within a "smart city" example, where connections between different portions of the city to provide public and private services are interdependent. Specific elements of traffic movement, urban agriculture, and government facilities are examples of these underserved CI sectors. The example will address a means to evaluate multiple networks performance as well as policies in order to evaluate the relationship to their interdependent networks.

Our hypothesis is that using this methodology will identify critical components of the smart city that serve as the keystone for successful city operations. If this keystone is disturbed, it may cause a cascading effect on the rest of the city, and have a greater impact than the less critical CI sectors. Our methodology will quantify the effect on all the CI sectors involved.

C5: The NIST Risk Management Framework in 30 Minutes

Richard Winslow

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:

1. Categorization of the system
2. Selection of security controls
3. Implementation
4. Assessment
5. Authorization
6. Monitoring

These six steps are related to the project lifecycle and explained in (nearly) understandable language.

By the end of this 30 minute presentation, attendees who pay any attention at all will have gained sufficient grasp of the NIST Risk Management Framework process to appear knowledge able when expounding on the process with their peers, with their management, and with potential customers and stakeholders. As a side benefit, they may increase their chances of producing a secure, accredited system down the road.

Presentation Abstracts for Friday

H3: Implementing Complex Interventions in Health Care: Sustainability of What?

Edmond Ramly and Kendra Kreutz

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 element to understand System-of-Systems impacts prior to implementing change.

Recent National reports have recognized the role that systems engineers play in improving and redesigning the health care delivery system. However, many applications remain limited in scope, focusing on cyber-physical problems like facilities and medical devices. When scope is expanded to cyber-social problems, to include people and organizational issues, a number of healthcare domain-specific challenges present themselves. Experience with cyber-social challenges suggests the need to move from application of systems engineering in health care to health systems engineering, a dedicated inter-discipline at the intersection of systems engineering and healthcare.

S2: The Agile Systems Pattern: A Reference Model for Agility in Systems

William Schindel

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) that can adapt well enough, in terms of time, cost, and effectiveness, are sometimes referred to as "agile systems". When the rate of environmental change or uncertainty increases, this sort of agility can become a basic framework for survival, competitive success, or failure.

Reviewing and extending the work of earlier pioneers, this presentation should be of interest to those who are responsible for planning, designing, or analyzing systems with enhanced agility, including products and services, as well as development, manufacturing, operational, and other life cycle processes, and to those who will lead, execute, use, manage, or acquire them. Attendees should expect to become aware of an MBSE-based reference architecture that can serve as a tool for accomplishing these challenging tasks, and also learn more about the INCOSE Agile Systems Engineering Life Cycle Model (ASELCM) Project.

S3: Sustaining Systems Engineering: The Critical Role of Product Lifecycle Management

C. Robert Kenley and Nathan Hartman

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 perceived value that systems engineers are delivering to the system's stakeholders and in sustaining a more meaningful and relevant participation of systems engineers throughout the system's lifecycle.

Presentation Abstracts for Saturday

S4: Ensuring Reliability of Future Mars Probes

Bret Rudnick

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., Sprit 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 operation, etc.? This paper will examine experience and lessons learned from all attempts and will propose a set of engineering principles and practices to increase the probability of success.

C6: An Agent-Based Modeling Approach to creating More Resilient Littoral Combat Architectures

Parth Shah, James Behmer, Kolawole Ogunsina and Suhas Srinivasan

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 breakdowns. The challenge for any SoS practitioner is identifying such architectures from a vast design space. We define an architecture as the constituent systems in the SoS and the connections among these systems.

We seek to apply an agent-based modeling approach to create an architecture evaluation tool that leverages the modular nature of a SoS to quickly conduct trade studies and analyses to identify architectures that are resilient to a variety of threats. The simulation tool is built on the principles of the Open Systems Architecture put forth by the DoD. We present an analysis that seeks to find both a feasible site placement of combat platforms and a suitable SoS architecture configuration that maintains operability and performance during/given the loss of command authorities. This loss can be attributed to battle casualties or other forms of threats including communications failures. We demonstrate that distributing managerial control in the architecture improves SoS performance in terms of time to threat elimination.

This single analysis demonstrates how SoS practitioners can use agent-based models to quickly construct and evaluate potential architectures against a variety of threats and disruptions, ultimately building resilient SoS architectures that perform to prescribed levels even in the face of network failures and/or attacks.

H4: Case Study: Application of MBSE Methods for Hospital Emergency Departments

Ajay Thukral

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 Challenge Team is building an Emergency Department (ED) model- based on MBSE approach.

ED is a complex system of interacting entities: patients, physicians, support units such as labs and care units, medical devices and instruments, pharmacy, health information system and compliance requirements. At heart of the ED system are the interactions among the several entities working concurrently executing critical care delivery processes. Patient's outcome relies on ED's efficiency and effectiveness in deploying its non-clinical and clinical services. Clinical decision making is time critical and requires availability of past and current clinical information at point of care. Evidence based approach is critical for ED care delivery and clinical effectiveness, and is included in ED's systems model.

While simulation models of EDs exist in the literature, the challenge team has not found an MBSE model of an ED. Therefore, the team's first work package is to build a logical model of ED starting with (1) emergency care use case of a diabetic patient in hypoglycemic state, (2) ED domain description, (3) stakeholder and feature analysis, and (4) ED interaction analysis. This is the first step towards a reference MBSE model for use in future challenge team projects and by the healthcare community. It will present a progress report covering systems analysis and different model views of ED.

S5: Systems Engineering Community of Practice Social Network Pattern

Christopher Hoffman and William D. Schindell

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 represent the social network pattern of a Systems Engineering Community of Practice (by performing Systems Engineering on Systems Engineering). The structure and services (processes, tools, people training) of a Community of Practice or Functional Excellence Area are modeled in order to form patterns for understanding and improvement of the SE Community of Practice system. The benefits of understanding this social pattern are then enabled through the relationships among the business processes, methods, tools, individual training, and the deployment of those products and services to the stakeholders. This pattern understanding can then be applied to multiple domains and other functional areas for similar replication.

C7: Using Systems Engineering Modeling Tools to Facilitate Earlier Identification of Safety, and Mission/Quality Assurance Requirements

Sean Beckman and Scott Darpel

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 design. This paper discusses an alternate paradigm for using the concepts of use case or activity diagrams to identify safety/hazard and mission/quality assurance risks and concerns using the same systems engineering modeling tools being used to identify technical requirements. It contains two examples of how this process might be used in the development of space flight experiment, and the design of a Human Powered Pizza Delivery Vehicle, along with the potential benefits to decrease development time, and provide stronger budget estimates.

H5: Application of PBSE to Improvement of EMR in Medical Practice

Vijay Thukral, Bill Schindel and Ajay Thukral

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 driven by CMS's (Medicare's) Meaningful Use incentives, but there has been growing concern about EMR's robustness and sustainability of resulting doctor-patient interaction quality. Issues include distraction of the practitioner from the patient, loss of content in converting traditional prose to structured data, data quality, clinical utility, and extensibility of EMR to unplanned use cases. This has led to resistance to acceptance. There is an increasing number of lawsuits associated with harm to patients caused by EMR failures.

EMR data points, once committed, become part of historic data and play a patient safety critical role. It is therefore critical to clearly specify concepts of use, measures of effectiveness, and technical requirements as to both data models and functionality. Knowing what data to collect and understanding the fundamental steps of collecting it can enhance the overall care delivery and practice management.

The current work focuses on the application of SE methods starting with (1) understanding the clinical context for EMR, (2) studying the requirements for a data entry and distillation solution and (3) synthesizing a data entry and distillation solution for clinical practice. The EMR data model will then be generalized to determining underlying pattern to support a class of EMR data entry solutions.

S6: INCOSE Certification: A Tool for Getting Your Next Job

Courtney Wright

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 capabilities to others. This presentation will address how the INCOSE Certification Process – whether you complete it or not – will make you a better SE and make you better at communicating your value to others, even those who are not familiar with INCOSE.

C8: Making Smart Cities Smarter – MBSE Driven IoT

Matthew Hause

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 Systems Engineering and Model Based Systems Engineering (MBSE) principals. Without MBSE, the complexity involved in the design, development, and deployment of IoT systems

would consume both system and operational providers. Absent of any industry standards, IoT systems cannot be built in a vacuum and their success will only be realized through application of modern day systems engineering processes, methods, and tools. With the potential of 28 billion "things" connected to the Internet by 2020, it's not too difficult for anyone paying attention to this emerging technology trend to envision the massive scale of social, economic, and technological changes that will need to occur to realize this prediction. Technology advancements in consumer products will continue to evolve to facilitate connection to larger and larger IoT networks. This will be the catalyst that will drive entire infrastructures changes to: Federal, State, City, and local governments; product development companies; utility and service providers; and even to consumers and their homes in order to support the growing demand for connected products. The infrastructure and management will need to be established prior to, or in conjunction with, the smart systems that support them. This paper will show a traffic management system and connected systems in a large city and how an MBSE and SoS approach will help guide development.

O1: Sketching with SysML: Proper Framing of Problems Leads to Innovative Solutions

Michael Vinarcik

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. This presentation will showcase how using SysML to describe the 2015 FIRST Robotics Challenge (Recycle Rush □) helped a high school robotics team to develop its robot. The necessary functions were clearly identified and enabled the team to translate needed capabilities into their design.

S7: Back to Basics – The Lines are Just as Important as the Boxes

David Walden

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 interfaces – both external and internal – of the system-of-interest. For a set of requirements, the lines represent the traceability relationships between the requirements. For projects, the lines represent the internal and external interaction of the various teams.

Presentation Abstracts for Saturday

S8: A Framework for Implementing Systems Engineering Leading Indicators for Technical Reviews and Audits

Chris Orlowski, Paul Blessner, Timothy Blackburn and Bill Olson

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 throughout the systems engineering life cycle. The paper seeks to improve and expand on the existing INCOSE systems engineering leading indicators that are significant predictors of program performance. Correlation between a set of leading indicators and technical reviews to support successful program performance is evaluated. Further research is planned to improve systems engineering by providing examples of performance measurement benchmarks that could aid technical reviews and decision gate analysis.

C9: Industrial Integration of MBSE into PLM for Mission Critical Systems

Saulius Pavalkis

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 this paper we will overview existing MBSE and PLM adoption cases already completed by number of our clients. Next we will identify the most important use cases to support MBSE and PLM integration. We will propose the integration methods.

O2: Using Model-based Product Line Engineering as a Decision Framework

Matthew Hause

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 all aspects of engineering including electrical, electronic, mechanical, chemical, etc. Model-Based Systems Engineering (MBSE) using the Systems Modeling Language (SysML) can capture the system aspects and assets, but not the variation. Orthogonal Variability Modeling (OVM) captures variation points, variants, dependencies and mutual exclusion constructs. These provide a natural decision selection process allowing engineers to perform trade-offs for specific customers and guide current and future system development along the most effective route. The evolution of the product line, potential variants, evolving technologies, future customer features, etc. can be modeled. It also provides a decision framework to guide development and ensure the most appropriate product for the market, domain and the customer. Using a decision execution engine, the engineer can review the results of the decision and perform trade-off analysis. The same techniques can be used for market analysis as well as detailed engineering making the techniques applicable for multiple stakeholders. Using various examples, this paper will describe Model-based Product Line Engineering, the process for creating product lines, variant modeling, mapping variation systems, product model creation, and how the adoption of MB-PLE early on in the development lifecycle provides benefits without the potential disruption and reengineering that can be involved when adopted later on in the lifecycle.

Presentation Abstracts for Saturday

S9: Got Phenomena? Science-Based Disciplines for Emerging Systems Challenges

William Schindel

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 components are integrated (constrained) by an overall Interaction, the emergent behavior of the resulting System may be quite different than the combined behaviors of the individual components in isolation. This well-known fact is the System Phenomenon, and is the basis of both values and challenges of engineered systems. It is described by the Principle of Least Action, expressed by the Calculus of Variations and Lagrangian mathematical models. It is one traditional path for derivation of equations of motion or other forms of physical laws of the so-called “fundamental” physical phenomena of mechanics, electromagnetics, chemistry, thermodynamics, and other discipline-specific phenomena.

The “fundamental” laws and phenomena of each of the specialized disciplines are thus less fundamental than the (recurring) System Phenomenon. The importance of this perspective is not just philosophical, but a reminder that there are ever-higher levels of systems with their own emergent phenomena, first principles, and physical laws. Recent successes include ground vehicles, aircraft, marine vessels, and biochemical networks. Those of future interest include utility and other types of distribution networks, biological organisms and ecologies, market systems and economies, health care delivery or other societal service systems, military conflict systems, and Internet-mediated systems.

The intended audience is anyone facing these higher-level systems challenges, and the objective is improved awareness of Systems Phenomenon tools for addressing them.

S10: Systems Engineering Pop Art

Jason Sherey

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 imperfect reality was the typical subject for the infamous pop artist Andy Warhol. He often concentrated on the “plasticness” (or the image of perfection) of Hollywood or the commercialized images of consumer goods. He pioneered the application of screen printing in art where he would make a portrait of typically a Hollywood star or consumer good and screen print many versions using different colors so that different aspects of the subject could be emphasized and compared. The smudges and smears created by the screen printing process are not only accepted, but they are viewed as an integral part of the art’s overall expression.

This presentation claims that systems engineers should embrace the inherent messiness of the design synthesis process and not fall victim to the idyllic dream that better modeling languages or software tools providing more detailed models will make the engineering process perfect. Pattern□Based Systems Engineering (PBSE) can use configurable models to “screen print” different perspectives of the same system where the “smudges” within each are not erased by fancier modeling languages or tools but are identified, managed, and used to improve the engineering process.

C10: An Examination of Interoperability in Systems Development

Matthew Hause

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 business view defines Interoperability as the task of building coherent services for users when the individual components are technically different and managed by different organizations. Interoperability goals include the following:

- Promotes information sharing
- Results in integrated planning and enhanced service delivery
- Reduces costs of information collection and management
- Improves decision making
- Improves the timeliness, consistency, and quality of responses
- Improves accountability and transparency of information
- Supports reusable, collaborative methods
- Improves security
- Improves readiness of partners to exchange and share information

A combination of all of the above is needed when looking at Interoperability at the systems of systems level, the normal domain of the Department of Defense Architecture Framework (DoDAF). DoDAF is the US industry-standard Enterprise Architecture Framework for defense and aerospace applications. DoDAF defines how to organize the specification of enterprise architectures for U.S. Department of Defense (DoD) applications. DoDAF is well suited to large systems and systems-of-systems (SoSs) with complex integration and interoperability issues. Although DoDAF is primarily focused on defense applications, it can also be applied to commercial systems. This paper will apply DoDAF to an electric grid to show organizations, people, systems, systems of systems, their interconnection and communications and how they change, operate and evolve over time to provide interoperability.

O3: Unlocking Model Based System Engineering through the Use of Patterns

Brian Merchant and David Cook

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 of system development from Requirement analysis and capture to Validation and Verification. A challenge with MBSE implementation is the development of methodologies that can deliver the potential benefits associated with MBSE. Patterns are one way to address this challenge. The application of MBSE patterns can provide a robust, scalable, and tool agnostic MBSE methodology.

This presentation includes an example to illustrate the application of the methodology and the potential efficiency increases that can be realized by encapsulating an organization’s intellectual capital into the model-based pattern. This example will also illustrate how embedding the organization’s knowledge into a model-based pattern can eliminate repetitive tasks and greatly reduce program cost and schedule risks.

O4: Richer Functional Decomposition: Using Operations and Methods in SysML

Michael Vinarcik

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. The behavioral model can grow from a single use case to a detailed description, with inputs and outputs clearly defined. Particular emphasis will be placed on the use of secondary work products (such as tables) that allow information to be extracted from the system model automatically and in a format useful to SMEs.

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