Western States Regional Conference 2024 Technical Program

Tutorial List

As of August 27, 2024

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#5 Understanding and Applying the Comprehensive System Design Language (CSDL), Sarah Rudder

This professional development tutorial will explore how the MBSE with CSDL is accomplished and how the integrated system data repository is created and subsequently utilized to create diagrams. CSDL is a structured Entity-Relationship-Attribute (ERA) language with well-documented semantics for each entity, enhancing collaboration by reducing ambiguity within most modeling languages.

The tutorial will go through the construction of an Unmanned Aerial System (UAS) using CSDL, starting with importing requirements through several SE activities. Attendees will learn how to use CSDL for modeling structural decomposition, use cases, and system functionality.

The proposed time for this tutorial is four hours and the topical outline includes:

- Introduction to CSDL
- Benefits of an ERA Language for MBSE
- Importing Requirements
- Grouping Requirements
- Setting up Requirements for Successful Verification
- Modeling System Structure
- Modeling System Use Cases
- Modeling System Functionality
- Modeling Relationships

• Creating Diagrams from the Data Repository
• Report Writing

The UAS design is most relevant to the aerospace and defense industry, but the underlying MBSE principles can be applied to any system.

#12 FULL-DAY TUTORIAL: Navigating the Future: Exploring SysML V2 with SysON- A Hands-On Tutorial, Stephane Lacrampe

This submission is made under the category "Tutorial" as a half day tutorial and as an "Advanced Technology Tutorial".

SysML V2 is a general-purpose modelling language, standardized by the OMG, for specifying, analyzing, designing, and verifying complex systems that may include hardware, software, information, personnel, procedures, and facilities (source: https://www.omgsysml.org/). It is the result of an extensive collaborative development effort that began in 2015 and involved more than 80 organizations. It is also the eagerly anticipated successor to SysML V1, addressing some of its limitations, and poised to play a key role in the Digital Engineering transformation in the years to come.

SysML V2 represents a significant evolution compared to SysML V1, including:
- It is no longer based on UML but on a new metamodel (KerML).
- It provides both textual and graphical syntax.
- It defines a standard API for accessing the model.
- It systematizes the concepts of definition and usage and provides variability capabilities.
- It provides enhanced extension capabilities and includes a large set of predefined model libraries.

Anticipating the adoption of the final specification in 2024, this tutorial aims to provide participants with a first experience in using SysML V2. No previous knowledge in SysML is required.

After an initial overview of SysML V2 key concepts and innovations, this tutorial will consist of an interactive hands-on experience where participants familiarize themselves with modelling in SysML V2. They will develop their own SysML V2 model through a system example used throughout the tutorial, covering the key features and functionalities of SysML V2.
This hands-on session will include Structure and Requirement modelling using the General view and Interconnection View, Behavior modelling using the Action Flow View and the State Transition View. We will also cover topics such as extending SysML V2 with your own library and how such extensions can be used. While we will provide an overview of the textual syntax, most of the exercises will be done using graphical representations. This tutorial will not focus on comparing or transitioning from SysML V1 to SysML V2 but rather on learning SysML V2 itself.

Join us on this journey to navigate the future of systems engineering with SysML V2.
Participants should come with their laptops as well as an internet connection (provided by the conference). The SysON open-source project (https://mbse-syson.org) will be used to support the modeling activities conducted in this tutorial. No installation is required.

Author Information:
Stéphane LACRAMPE co-founded Obeo in 2005 in France. Obeo is an independent software vendor with a global reach, leading in open-source modelling software for system and software engineers, enterprise

architects, and domain modelling experts, and supporting the open-source MBSE tools Capella and SysON.
Stéphane LACRAMPE acted as the company's CEO until 2018 and is now the director of Obeo Canada. Stéphane LACRAMPE is in charge of developing the Capella and SysON ecosystem in North and South America as well as in Asia. He is a regular speaker in Systems Engineering conferences like INCOSE IS or in events organized by local North American chapter, and has already delivered online and on-site tutorial on Capella. Stéphane LACRAMPE is also the co-chair of the INCOSE Systems Engineering Tools Database Working Group and board member of the INCOSE Canada chapter.

#15 HALF-DAY TUTORIAL: Requirements: A Comprehensive Overview, Rick Hefner

This presentation delves into the use of systems engineering tools for defining and enhancing business processes. By drawing parallels between systems engineering in product development and process design, it explores the commonalities in the artifacts and methodologies employed across both domains.

In the realm of business processes, adopting a systems approach enables a thorough grasp of organizational dynamics, facilitating the identification of inefficiencies, bottlenecks, and avenues for enhancement. The systems engineering (SE) methodology emerges as a versatile framework for structuring, analyzing, and optimizing systems, whether they pertain to tangible products or operational workflows. Key artifacts like stakeholder needs, functional requirements, operational behavioral diagrams, and system architectures find leverage through established methodologies and tools.

Furthermore, the integration of systems thinking with Lean Six Sigma methodologies, particularly the DMAIC (Define, Measure, Analyze, Improve, Control) and DMADV (Define, Measure, Analyze, Design, Verify) frameworks, offers additional avenues for refinement. Through practical examples, this presentation illustrates how this integration enriches the process design paradigm.

#16 HALF-DAY TUTORIAL: Mastering Your Systems Engineering Competencies, Rick Hefner

To excel in systems engineering, professionals must possess a diverse set of competencies. This tutorial provide a thorough and practical guide for professionals looking to develop the competencies outlined in the INCOSE Systems Engineering Competency Framework. It offers a structured approach that encompasses both theoretical knowledge and practical application, catering to individuals at various stages of their careers, from novice practitioners to seasoned experts.

The framework identifies a wide range of competencies, organized in the following categories:
• Core Competencies: Systems Thinking; Lifecycles; Capability Engineering; General Engineering; Critical Thinking; Systems Modelling and Analysis
• Professional Competencies: Communications; Ethics and Professionalism; Technical Leadership; Negotiation; Team Dynamics; Facilitation; Emotional Intelligence; Coaching and Mentoring
• Technical Competencies: Requirements Definition; System Architecting; Design for…; Integration; Interfaces; Verification; Validation; Transition; Operation and Support;
• Management Competencies: Planning; Monitoring and Control; Decision Management; Concurrent Engineering; Business & Enterprise Integration; Acquisition and Supply; Information Management; Configuration Management; Risk and Opportunity Management
• Integrating Competencies: Project Management; Finance; Logistics; Quality

Participants will assess their own skills against the framework and identify areas for improvement, for both the current roles and career goals. Then practical guidance will be provided on how to acquire new

skills and improve existing ones. By the end of the tutorial, participants will be equipped with the knowledge, tools, and mindset necessary to enhance their systems engineering capabilities. Whether embarking on a new career path or seeking to advance in their current role, participants will emerge from the tutorial empowered to tackle the most challenging systems engineering problems with confidence and competence.

#24 HALF-DAY TUTORIAL: Integrating System Architecture in SysML with Hardware for Rapid Prototyping and Validation and Verification, Saulius Pavalkis

Faster time to market and more and more software intense systems requires higher level of integration and faster decisions that are more informative. This is accomplished leveraging the best practices of model-based systems engineering (MBSE), digital engineering, engineering disciplines integration enabling faster prototyping and V&V.

This hands-on tutorial explores the integration of system architecture in SysML with hardware through the Internet of Things (IoT) protocol and other means. Connecting SysML with hardware, specifically Arduino, allows for real-time and rapidverification and validation (V&V) and prototyping of systems. The tutorial covers the vocabulary, technology stack, architecture of the connection solutions and actual connection libraries. It provides the integration of the connection in the tool of choice - CATIA Magic, and required library for connecting to other hardware using IoT protocol and other means. The demonstration showcases the seamless interaction between system architecture and hardware, emphasizing the importance of model based systems engineering (MBSE) enabling bridging the gap between system requirements in the model and hardware implementation for fast prototyping and (V&V).

• Structure and Format:
**Hands-on
**4hours - half-day session, providing adequate time for hands-on activities and in-depth coverage of concepts and solution.
**Products, licenses, samples and hardware provided:
***CATIA Magic
***Arduino IDE
***Hardware
***Library for connection to hardware using IoT protocol and other means.
• Knowledge Level: Assuming familiarity with systems engineering (intermediate), but new to IoT and Hardware integrations or concepts (beginner).
• Position within Systems Engineering: The tutorial positions itself within the realm of systems engineering, focusing on system architecture and its practical application in real-world environment for fast prototyping and V&V.
• Target Audience: Targeted at systems engineers interested in digital engineering, IoT applications, Prototyping, V&V.
• Practical Uses:
** Participants can directly apply the knowledge to real-time verification of engineering designs.
** Provided library, sample models, and hardware will create experience and abilities to reproduce integration with other model, and hardware.
• Organizational Improvement: The skills taught can lead to enablement and improvement how systems architecture is used for V&V and prototyping, and how it is integrated with hardware.
• Professional and Personal Value: Offers significant value to attendees by enhancing their professional

capabilities in systems engineering and digital engineering.
• Demand: due to faster time to market, and more and more software intense systems digital engineering, engineering disciplines integration, faster prototyping and V&V integrating SysML, IoT and hardware is a high-demand area.
• Attractiveness: The hands-on aspect, provided solution enabling skill, and practical implementation focus make this tutorial attractive.
• Educational Nature: Highly focuses on educational aspect, hands-on, sharing method, tools and samples, not on selling a product, despite mentioning specific solutions.

#28 FULL-DAY TUTORIAL: Risk, Safety, and Reliability Analysis in Model Based System Engineering (MBSE) [A Tutorial], Ron Kratzke, Brian Pepper and Bill Bentley

The Object Management Group (OMG) released a standard providing standard processes for Risk Analysis Assessment Modeling Language (RAAML). The analysis techniques and requirements discussed in this standard are an integral and important part of engineering today's complex systems. This is particularly important in the aerospace, automotive, energy, and defense industries.
The RAAML standard includes: Failure Mode and Effects Analysis (FMEA); Fault Tree Analysis (FTA); System Theoretical Process Analysis (STPA) methods; and Functional Safety Analysis in accordance with ISO 26262.
These analysis techniques have generally been accomplished using unique tools by subject matter experts. This tutorial explores these applications in the context of Model Based System Engineering (MBSE). In the RAAML standard, each of these analysis techniques are defined as extensions to the general System Modeling Language.
Students in the tutorial will explore the extension for each of the techniques and construct examples based on a common system design model.
Specifically we will cover the following in the tutorial:
1.) Introduction to the RAAML Standard
2.) Development of a Failure Mode and Effects Analysis (FMEA)
3.) Development of a system fault tree using Fault Tree Analysis (FTA)
4.) Application of System Theoretical Process Analysis (STPA) methods for system risk management
5.) Conduct of a Functional Safety Analysis using ISO 26262
6.) Conclusion and summary by understanding the commonalities and differences in the methods
This tutorial is design to take 8 hours to accomplish, but can be condensed to 4 hours by streamlining the hands-on development of each analysis.

#33 HALF-DAY TUTORIAL: Use a Framework for SE in Early-Stage R&D to Build Your Bridge that Spans the Chasm Between Research and Engineering, Ann Hodges

Abstract: Researchers and funding organizations often do not understand the value of systems engineering in early-stage projects, defined as technology readiness levels TRL 1-5, during which systems engineering may be viewed as an unnecessary cost, and as a process-heavy effort applicable only for mature technologies. This may result in a relative lack of engineering rigor and of understanding of innovation context which often contributes to failures leading to the "valley of death" between fundamental research and applied development. There is more than one pathway for crossing the valley of death, and relevant application of systems engineering implemented at an appropriate level of rigor provides a foundation for transition and use of technical innovation. This tutorial, updated from IS2024, provides an overview of the valley of death associated with technical and product incubation, the principles and foundational elements necessary for transitioning research projects to engineering development that bridges this valley of death, and presents a framework for systems engineering

applicable in early-stage research and development (ESR&D), including tailoring considerations associated with TRL, stakeholder roles, and relevance to the use of MBSE and Digital Engineering. Associated framework metrics are presented to enable evaluation and practical implementation of the framework for systems engineering innovation management at this phase of technology development.

Outline:
1. Introductions – instructors and participants, ask participants to share {name, organization, their domain(s) of experience (e.g., academia, communications, IT, etc.), problems experienced with applying SE in research
2. Problem statement for systems engineering (SE) in early-stage R&D - issues and impacts
3. Framework elements overview – emphasize the framework is applicable to a range of research project types and scale (single project, to program [set of projects] to enterprise level), use critical thinking to include other relevant and useful approaches (e.g., design thinking, agile methodology)
a. Value proposition expressed in terms understandable to stakeholders. Exercise: Break into groups, participants provide their perspectives given their domain experiences, debrief with larger group
b. Framework principles overview – Group Q&A: ask participants for feedback
c. Standards basis overview – Group Q&A: as a group discuss standards that are relevant for participants' domains
d. Risk-based graded approach overview – Exercise: Break into groups, discuss whether participant case studies are low or higher rigor (e.g., "moon shot", grand challenge)
e. Present TRL roadmap for SE activities, artifacts, assumptions concerning the roadmap – group Q&A: discuss assumptions
f. MBSE & Digital Engineering – Group Q&A: as a group discuss models that are useful for the SE activities and artifacts. Discuss relevance of tool choice on integration, usability, and "buy-in" of others.
g. Research domain types – present overview of the layers of practices/artifacts: common core of practices/artifacts; tailored extensions (e.g., methodology, organizational); domain specific
h. Training/coaching – Principal Investigator/research team and Systems Engineer coach each other so that each has sufficient domain knowledge to apply the TRL roadmap
i. Measures and metrics overview – present overview and core set of measures/metrics
j. Continuous improvement – present how measures/metrics are used to provide insight for improvement, gather lessons learned during execution of planned activities/artifacts from TRL roadmap, turn lessons learned into lessons applied
k. Present suggested flowchart for key decisions in using the SE in early-stage R&D framework elements
4. Using the SE in early-stage R&D framework elements – Exercise: Break into domain groups. Each group:
a. Discuss changes to value proposition and principles for the domain's specific culture
b. Discuss domain-specific standards to consider in the TRL roadmap for SE activities/artifacts
c. Discuss appropriate rigor for the domain – may evolve during TRL maturity
d. Tailor TRL roadmap for domain-specific standards, processes, practices, deliverables – select at least 2 process areas in the roadmap
e. Tailor measures and metrics for the domain
f. Each group presents their results to the wider group

Primary learning objectives - what the participants will gain:
1. Participants will learn about challenges associated with transitioning research to engineering development.
2. Participants will learn about the framework elements that support technical planning for transitioning research to engineering development.

3. Participants will apply the framework elements to a domain-specific case study of their choosing.
4. Participants will learn about an approach that address challenges highlighted in the SE Vision 2035: use of multi-disciplinary analysis collaboratively (researchers/systems engineers), an analytical framework for planning SE activities and deliverables in early-stage R&D, explore domain patterns for SE activities/deliverables.
5. Participants will learn about an approach that helps to normalize relevant SE practices and deliverables that support successful transition of research to engineering development, and that can provide a basis for reuse of SE assets at a domain level – steps in the practices facet of the SE Vision 2035 top-level roadmap.

Presenter biography:
Ann Hodges retired after 48 years of service at Sandia National Laboratories (SNL) and was a distinguished member of technical staff. She was the Mission Services Division's systems engineering lead for the systems engineering part of the project and product delivery system (PPDS) at SNL and was a project manager and systems engineer for a complex exploratory-phase project. She is a primary author of the risk-informed graded approach to the application of project management, systems engineering, and quality management which is one of the key aspects of the PPDS. She collaborated with the Laboratory Directed R&D program office to tailor the application of PPDS to SNL's research portfolio.

Tutorial experience and other relevant background:
• Co-presented a tutorial on "Integrating SE, Project Management and Quality Management" to the INCOSE Enchantment Chapter in 9/2017 and INCOSE IS2018.
• Co-presented this submitted tutorial to INCOSE IS2024.
• Was project manager and SE for a complex exploratory-phase project and collaborated with the SNL Laboratory Directed R&D program office to tailor the application of PPDS to SNL's research portfolio.
• Co-developed PPDS instructional materials, and taught PPDS concepts to over 200 management and staff members.
• She co-chairs the SE in Early-Stage R&D Working Group and was co-editor and co-author of several papers in INSIGHT volume 26 issue 3, "SE in Early-Stage R&D: Bridging the Gap."