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PPI SyEN

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WELCOME

Greetings! Thank you for picking up the November edition of PPI SyEN.

But wait...

Did you pick up your phone to read this or did you not pick up anything and you are reading this off of your computer screen? One way or another you're likely reading this on a screen unless you're seriously committed to PPI SyEN and print the edition every month to mark up and take notes on because – why wouldn't you? (just kidding, unless you're into putting pen to paper like that)

This is a digital newsjournal. Digital. The word of the century perhaps. Digital threads, digital engineering, digital twin, etc. – you can't set your foot in any engineering conference without hearing somebody speak about it. As our immersion into the world of digitization increases with artificial intelligence and autonomous technologies, we simultaneously are facing unprecedented challenges with climate change, war and natural disasters.

It's hard not to feel overwhelmed by the state of the world at times and sometimes you may think to yourself, what's the point of all of this? You may not feel like going in to work – let's get real, we all have those days. However you do get up and go anyway, or maybe you go to your home office and work virtually, whatever the case may be, we show up because we want to make an impact on the world, we want to make the world a better place – that's why you're an engineer at the end of the day? Perhaps you're not an engineer, you may be a project manager, a commerce student or you may just like torturing yourself by reading technical texts in that case, you are an honorary engineer in my books anyway.

Regardless of what you do, you picked up this newsjournal because you have a thirst for learning and a desire to help humanity and this is a wonderful time to be in your position because information is so freely available and technology is so powerful. We really have the capacity to address challenges like economic inequality, climate change and many other things that we are experiencing right now. What a beautiful thing! It's daunting but it's possible. People like you make me believe that it is so.

Systems engineering has the power to change the world and this is what helps me to get up and work every morning – even on the days when I don't feel like it.

Well, you eager learners are in for a treat in this edition with lots to learn about how to navigate from where we are to the future we want to see with the power of digital engineering.

Enjoy!

René

Managing Editor, PPI SyEN

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Views expressed in externally authored articles are not necessarily the views of PPI nor of its professional staff.

PPI Systems Engineering Newsjournal (PPI SyEN) seeks:

- To advance the practice and perceived value of systems engineering across a broad range of activities, responsibilities, and job-descriptions
- > To influence the field of systems engineering from an independent perspective
- To provide information, tools, techniques, and other value to a wide spectrum of practitioners, from the experienced, to the newcomer, to the curious
- To emphasize that systems engineering exists within the context of (and should be contributory toward) larger social/enterprise systems, not just an end within itself
- To give back to the Systems Engineering community

PPI defines systems engineering as:

an approach to the engineering of systems, based on systems thinking, that aims to transform a need for a solution into an actual solution that meets imperatives and maximizes effectiveness on a whole-of-life basis, in accordance with the values of the stakeholders whom the solution is to serve. Systems engineering embraces both technical and management dimensions of problem definition and problem solving.

Recent events and updates in the field of systems engineering

News from the IEEE Systems Council



The IEEE Systems Council integrates activities across numerous IEEE societies including Aerospace & Electronic Systems (AESS), Circuits & Systems Society (CAS), Communications Society (ComSoc), Computer Society, Consumer Technology Society (CTSoc), Control Systems Society, Industry Applications Society (IAS), Industrial Electronics Society (IES), Information Theory Society, Instrumentation & Measurement Society, Microwave Theory & Technology Society (MTT-S), Power Electronics Society

(PELS), Product Safety Engineering Society (PSES), Robotics & Automation Society (RAS), Society on Social Implications of Technology (SSIT), Systems, Man, and Cybernetics Society (SMC), Technology & Engineering Management Society (TEMS), and Vehicular Technology Society (VTS).

The IEEE Systems Council has announced updates to its mission statement and field-of-interest statement to:

- Embrace a broad approach to systems engineering, including systems thinking.
- Highlight the importance of *equity*, *diversity*, *inclusion*, and *belonging* in the collaborative process of engineering systems.

As a result, the System Council's mission statement now reads:

IEEE's mission to foster technological innovation and excellence to benefit humanity requires the talents and perspectives of persons with various personal, cultural, and disciplinary backgrounds. As is IEEE, the Systems Council is committed to advancing diversity in the technical profession, and to promoting an inclusive and equitable culture in its activities and programs that welcomes, engages and rewards those who contribute to the field without regard to race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression. In short, the Systems Council is committed to creating a Culture of Belonging for everyone.

The updated field-of-interest statement now reads:

The Systems Council integrates IEEE activities regarding aspects of multiple disciplines and specialty areas of systems engineering, and covers, but is not limited to, the following:

- Systems thinking
- Systems-engineering education, standards, processes, methodologies
- Systems modeling, simulation, integration, resilience
- Robust design, safety and human factors, security, usability, environmental aspects
- Product transition: design, production, test, deployment, disposal
- Program and project management
- Quality assurance
- Mission assurance
- Requirements development and management
- Risk management
- Systems architecture
- Systems of systems

A broad range of additional news has been reported by the Council, including:

- The 2022 IEEE Outstanding Service Award has been given to Andy Chen for his work on the Council's Administrative Committee and as Vice President for Conferences.
- The IEEE Systems Journal (ISJ) has raised its Impact Factor from 3.9 to 4.8 in the past year.
- Hanwen Yu is the new Editor-in-Chief for the *IEEE Journal on Miniaturization for Air and Space Systems* (J-MASS)
- Concerning the new IEEE Open Journal of Systems Engineering (OJSE), W. Dale Blair of the Georgia Tech Research Institute (GTRI) and Ljiljana Trajkovic of Simon Fraser University have been appointed as the founding Editor-in-Chief (EiC) and Associated EiC, respectively.
- The Women in Systems Engineering (WiSE) group hosted two webinars in the third quarter and has issued a membership call.
- The Council has issued a call for member participation in its numerous Technical Committees.
- The IEEE Bangalore Section Systems Council Chapter, in collaboration with INCOSE India Chapter and The Aeronautical Society of India, organized the 2nd Model Based Systems Engineering (MBSE) Summit in May 2022 and held its flagship conference (CONECCT 2022) in July 2022.
- The IEEE International Symposium on Systems Engineering (ISSE 2022) was held in Vienna, Austria on 24-26 October.
- The IEEE International Conference on Recent Advances in Systems Science and Engineering (RASSE 2022) conference was held at National Cheng Kung University (NCKU) in Tainan, Taiwan on 7-10 November.
- Save the Date announcements have gone out for two major events, the IEEE International Systems Conference (SYSCON2023) in Vancouver, Canada on 17-20 April 2023 and International Symposium on Circuits and Systems (ISCAS 2023) in Monterey, California, USA on 21-25 May 2023.
- A Call for Papers has been issued for a special issue of the IEEE Systems Journal (ISJ) on *Artificial Intelligence for Next Generation Industrial Cyber-Physical Systems* with paper submissions due on 30 December 2022.

See details on these and more Systems Council news items. Learn more about the IEEE Systems Council here.

NDIA Systems Engineering Excellence Group Award



The U.S. National Defense Industrial Association (NDIA) has announced the winning team for the Lt General Thomas R. Ferguson Systems Engineering Excellence Group Award. Established in 2003, the award honors the memory of Lt Gen Thomas R. Ferguson, Jr., USAF whose leadership

embodied the highest ideals in the development and deployment of defense systems.

The winning team consisted of the Object Management Group's (OMG's) Space Domain Task Force, the INCOSE Space Systems Working Group, Dassault Systems 3DS, and Orbital Transports, which developed a CubeSat System Reference Model[™] (CSRM[™]). A CubeSat is a low-cost, standardized satellite for secondary payloads often deployed from the International Space Station or ride share opportunities. The CSRM Logical Model, based on OMG's System Modeling Language (SysML[™]), in intended to help international academic, commercial, and government organizations and manufacturers lower development costs and increase the quality of CubeSat spacecraft.

For details, see the OMG press release.

Learn more about the Cubesat reference model here. Learn more about OMG's space-related efforts. Learn more about NDIA here.

INCOSE Publishes Letters to My Younger Self

INCOSE has published a compendium of letters from around the world, written by 25 system engineers in the field to their younger selves. The letters recount the lives lived by these diverse individuals; a global mix of leading systems engineering practitioners who highlight the insights gained along their careers. Titled "*Letters to My Younger Self - How Systems Engineering Changed My Life*", the 92-page eBook is a means of "paying it forward" according to Kerry Lunney, one of the authors and INCOSE President from 2020-2021.

Authors and their stories include:

Virginia Aguilar	Sueña en grande, trabaja duro
Eileen Arnold	A Journey of Passion
Heidi Davidz	Systems Engineering as a Natural Home
William Donaldson	Thoughts About the Road Ahead
lan Gibson	All Change! The Ultimate Evolving Career
Stueti Gupta	Be Uncomfortable with Comfort Zones
Heidi Hahn	A Random Walk Through Life
Cecilia Haskins	Oh, the Places You'll Go!
Lisa Hoverman	There and Back Again: A System Thinker's Letter
Randall lliff	WB9IRF calling WB9IRF, Please Come In
Serge Landry	Shaping Your Journey Through Life
Lefei Li	Our Wonderful 'System' Journey
David Long	Looking from Technology and Parts to Humans and the Whole
Kerry Lunney	Exploring Your World Through Systems
Roger McCowan	Exploring the Exciting World of New, Novel, and Complex
Dorothy McKinney	Experimenting to Kickstart Your Learning Journey
René Oosthuizen	A Message to Younger ME - A Systems Engineering-Inspired Guide to Wisdom
Erika Palmer	Systems at any Age
Bill Parkins	Making the Connection: A Systems View of an Engineering Journey
Ramakrishnan Raman	The Futurist's Dilemma
Federica Robinson-Bryant	A Testament to Persist
Ad Sparrius	"we are what we repeatedly do. Excellence, then, is not an act, but a
Alice Squires	Making Your Place in the World
Heinz Stoewer	Space Exploration and Systems Engineering, a wonderful challenge for
	a young engineer
Celia Tseng	An Immigrant's Perspective

Writing of the privilege of contributing to this work, PPI's Randall Iliff says,

"There are two challenges when trying to share insight with someone earlier in their journey, even hypothetically your younger self. The first challenge is finding something useful to share, but every life is filled with those. The second challenge is much more difficult – figuring out exactly how to encode that learning into a form recognizable by someone who does not yet have your full experience to draw upon. It's as though the universe placed a diode in everyone's learning path – forward is easy, but sending anything the other direction requires enormous voltage to overcome the barrier, but extremely limited current lest it fry the device."

PPI SyEN thanks the authors for sharing their journeys, the editors (Alice Squires, Lisa Hoverman and David Long) for pulling together this meaningful volume and SPEC Innovations for sponsoring the publication of Letters to My Younger Self (LTMYS).

Download the LTMYS eBook here.

PPI's Systems Engineering Goldmine Continue to Grow





PPI continues to add resources to the Systems Engineering GoldmineGeria (SEG). Documents recently added to the SEG include:

Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs This guide is one of several Department of Defense (DoD) policy and guidance documents that address the Department's focus on risk management. (Source: U.S. Department of Defense)

DMTC Guideline: Technology Readiness Levels

This guide delivers Technology Readiness Levels (TRLs) processes by providing a common language whereby the status of a technology can be described without the need to understand the technology itself. (Source: Australian Defence Materials Technology Centre)

DOORS Work Instructions

The purpose of this work instruction is to capture the steps necessary for the DOORS Administer (DA) to configure and use DOORS to support the System Manager (SM) in development and management of requirements (both specification and verification) documents. (Source: The National Aeronautics and Space Administration)

Enterprise Architecture

This webinar presented by University of California (UC) covers the topic of enterprise architecture, including methodology, roadmaps, and EA services. (Source: University of California, Berkley)

Human Factors Simulation Concept

Data item description showing format and content preparation instructions for the Human Factors Simulation Concept. (Source: U.S. Federal Aviation Administration (FAA))

Incremental Commitment Model Update

This presentation updates the ICM on Risk-driven framework for tailoring system life-cycle processes, Integrates the strengths of phased and risk-driven spiral process models Synthesizes together principles critical to successful system development. (Source: University of Southern California)

Integration of Systems with Varying Levels of Autonomy

It is intended that this report should be a tool for scientists and engineers working both in research and development and in systems acquisition. For the former, it should denote areas where knowledge, technology or tools are poorly developed or even lacking. These areas become candidate areas for research. (Source: NATO Research and Technology Organisation)

Requirements Questionnaire and Checklist

This Requirements Questionnaire and Checklist has been assembled to organize sample questions each program should ask when developing its formal requirements documentation for a commercial off the shelf (COTS) software project.. (Source: DOD ESI www.esi.mil)

Site Installation and Integration Plan

Data item details the Contractor's efforts from delivery through the completion of Government acceptance testing at the site. (Source: U.S. Federal Aviation Administration (FAA))

Technical Manual Verification Incorporation Certificate

This Data Item Description (DID) contains the format and content preparation instruction for the data product generated by the specific and discrete task requirement as delineated in the contract. (Source: U.S. Department of Defense)

The Engineering Roles of Requirements and Specification

This white paper introduces an enhanced refence model clarifying the distinction and link between requirements and specification in software engineering. (Source: University of Virginia USA)

The SEG is a free resource, intended for use by clients, alumni and friends of Project Performance International (PPI) as well as clients, alumni and friends of subsidiary company Certification Training International (CTI). If you do not already have access to the Systems Engineering Goldmine, you may apply for free access here.

Call for Papers on Enterprise Architecture (EA) Research Trends



Software and Systems Modeling (SoSyM) is a quarterly international journal (published in English) that focuses on theoretical and practical issues pertaining to the development and application of software and system modeling languages

and techniques. The aim of the journal is to publish high-quality works that further understanding of the theoretical underpinnings of modeling languages and techniques, present rigorous analyses of modeling experiences, and introduce scalable modeling techniques and processes that facilitate rigorous, efficient, or economical development of software.

SoSyM has issued a call for papers to address the theme of "*Trends in Enterprise Architecture Management Research*". Topics of interest include:

- Digital transformation: Consequences for EA (or the role of EA in) digital transformation, including e.g., migration to data stream architectures, digital platform ecosystems, Big Data, IoT, etc.
- Enterprise architecture modeling and analysis: Including modeling languages, model-based analysis and analytics, reference models, viewpoints, human-model interaction, EA and AI etc.
- Enterprise cyber risk management: Managing cyber risks, which include e.g., cyber security risks, but also other risks, such as the negative consequences of AI-based errors, systemic ripple effects, etc.
- Enterprise architecture decision-making and decision-execution: Including drivers for change, architecture governance, stakeholder management, etc.
- Cases and tool implementations

Deadlines for this publication opportunity are:

• 30 November 2022: Intent to submit

• 8 March 2022: Paper submission

View the Call for Papers.

View SoSyM 2022 best papers and journal-first papers (available as open access through 21 December 2022).

Tool Updates in the SE Tools Database (SETDB)

Systems engineering tool vendors continue to add and update their software tool offerings in the Systems Engineering Tools Database (SETDB). SETDB was developed by PPI in partnership with INCOSE; see feature article in SyEN Edition 112, May 2022 for this history. Recent SETDB updates include:

Vendor: Advanced Visual Systems Inc.

- OPENVIZ: OpenViz is the ultimate API, created specifically for ISV and OEM teams committed to go beyond basic charts and turn their data into actionable analytics. OpenViz is flexible, interactive, highly scalable and easily integrates with existing applications.
- AVS/Express: AVS/Express's drag-and-drop capabilities, rapid user-interface, advanced visualization methods, and cross-platform compatibility enhance the engineering, medicine, telecommunications, and environmental research fields needs to handle heavy graphics demands with an intuitive interface.
- Toolmaster: The preferred cross-platform C++ API graphics library by leading software houses and in-house application development teams around the world. It's the most comprehensive toolset available for visual data analysis and presentation, tried and tested in the harshest environments spanning three decades.
- AVS5: AVS5 is AVS' famous Network Editor. It is a unique Visual Programming Environment that let's you graphically connect AVS modules to build a reusable visualization network for powerful scientific and technical visualization applications.
- Gsharp: Gsharp can import any type of data from any source, create, and modify your graphs easily with intuitive, drag-and-drop tools. It provides unsurpassed interpolation, an extensive function library, batch-mode graphics, and the ability to create multiple graphs and axes from a single plot.

Vendor: Agent oriented Software (AOS)

- JACK®: JACK is a mature, cross-platform environment for building, running and integrating commercial-grade multi-agent systems. It is highly portable its Java foundation means that JACK can run with multiple threads across multiple CPU's and is easily integrated with third-party libraries.
- JACK Teams[™]: JACKTeams[™] supports the definition of autonomous teams. Each team exists as an entity with separate beliefs from those of its constituent agents. This supports a wide variety of teaming algorithms and allows the representation of social relationships and co-ordination between team members.
- JACK Sim[™]: In agent-oriented programming, a system is modelled in terms of agents. These agents are autonomous reasoning entities capable of making proactive decisions while reacting to events in their environment. JACK Sim[™] facilitates the development of 2D visualizations of model execution.

Vendor: Perforce Software

• HELIX QAC: Helix QAC is a preferred static code analyzer in tightly regulated and safetycritical industries that need to meet rigorous compliance requirements. It is certified for functional safety compliance including IEC 61508, ISO 26262, EN 50128, IEC 60880, and IEC 62304

Vendor: Systecon North America

- Opus Suite: Opus Suite gives you fast, accurate analyses, optimization, simulation and answers at your fingertips, throughout your system's whole life cycle. It helps you take control over performance and life cycle cost.
- OPUS10: OPUS10 is synonymous with cost effective spare parts optimization. With its realistic modeling of technology and support solution, rapid calculations, and results that reduce the spare part investment by 30% or more while also increasing system availability and providing valuable decision support.
- SIMLOX: Provides realistic simulations of operation and maintenance to maximum availability and capability, potential problems and test possible measures to prevent them. It provides reliable decision support when designing a logistic support solution to determine if planned operations can be performed
- CATLOC: CATLOC is a complete and flexible cost/revenue analysis tool that allows users to decide the scope, focus, approach and level of detail. It is equally suited for life cycle cost analysis, budgeting and planning, financial risk assessments, and control of ongoing projects.
- EVO: Opus Evo provides two main capabilities tactical optimization of the procurement of spare parts and support equipment for defined budget periods and optimization of maintenance capabilities for international missions and other deployed operations.
- Insights: OS Insights is a stand-alone program, easily deployed and has a direct data interface with the Opus Suite tools, allowing optimization and simulation results to be instantly available for dashboard visualizations. OS Insights is essential to help your organization make the right LCM decisions.

Vendor: Third Millenium Productions Inc.

• TMP Vision®/SLIM: TMP Vision® and SLIM were designed to meet the demanding needs of engineers analyzing complex FEA models. For over 20 years, these tools and their predecessors have played an increasingly important role in the visualization, interpretation and documentation of finite element models. TMP Vision® and SLIM are used in conjunction with a finite element analysis environment. TMP Vision® reads NASTRAN and ABACUS files directly making it much easier to interrogate models before processing.

Vendor: Wolfram Research

- Mathmatica: Mathematica provides a single integrated, continually expanding system that covers the breadth and depth of technical computing—and is seamlessly available in the cloud through any web browser, as well as natively on all modern desktop systems.
- System Modeler: Wolfram System Modeler is a next-generation modeling and simulation environment for cyber-physical systems. Using a large built-in and expandable modeling library, you can build industrial strength, multidomain models of your complete system to analyze and quickly iterate system designs.

SyEN readers are encouraged to check out these new and updated systems engineering tool offerings. Access the SETDB website.

Webinar: Agile Systems Engineering - Managing Models with Pipelines

🕕 LieberLieber

On 30 November, Daniel Siegl of LieberLieber will deliver a webinar with the above-named title. *The webinar will address* trends such as agile development or mass-customization (Lot-

Size 1) that require maximum flexibility during production. To cope with the resulting complexity, more and more companies are nowadays using system modeling. Here, products can be managed on a more general level using models. Currently, these models are still considered independently from the rest of the development process. As a result, every change in a model requires several manual steps to consistently perform this change on all dependent development artefacts. This is not practicable any more in an agile development environment.

To cope with this agility, current modeling practices must be enriched with a process view. Therefore, models can be integrated into existing DevOps-processes. This webinar will showcase how such a DevOps-solution for models can look like. A Continuous Integration process will be presented that uses modeling tools together with Git for versioning and deployment of system engineering models.

Register here. Learn more about LieberLieber.

INCOSE San Diego Mini-Conference



The INCOSE San Diego (California, USA) chapter will host a one-day in-person Systems Engineering Mini-Conference on Saturday, 3 December. The keynote speaker will be Dr. Paul Bevilaqua, former Chief Engineer of the Skunk Works who played a leading role in the creation of F-35 Lightning II Joint Strike Fighter.

<u>Keynote abstract</u>

The F-35 Joint Strike Fighter was developed to meet the multirole fighter requirements of the US Air Force, Navy, Marine Corps, and our allies. The Air Force variant is a supersonic, single engine stealth fighter. The Navy variant has a larger wing and more robust structure in order to operate from aircraft carriers, while the Marine Corps variant incorporates an innovative propulsion system that can be switched from a turbofan cycle to a turbo shaft cycle for vertical takeoff and landing. Lockheed Martin won the Joint Strike Fighter competition when the X-35 demonstrator aircraft made a short takeoff, went supersonic, and then landed vertically, the first time any aircraft had accomplished this feat. This presentation will describe the technical and program challenges involved in developing the Joint Strike Fighter and show how an innovative idea became an international program with engineers from half a dozen countries developing a single replacement aircraft for multiple aircraft types.

Other planned presentations at the Mini-conference include:

- Current and Future Challenges in Systems Engineering of Intelligent Systems (Michael Kremliovsky)
- When Less is More: Creating a Systems Engineering Essentials Course (John Wood and Glenn Tolentino)

- Creating a Learning Lab to Improve the Engineering of Cyber Physical Social Systems (John Wood, Jon Wade and Rick Gessner)
- The Case for a Science of Laws (Michael Martin)
- Cyber Security: RING Regional Incentive for the Next Generation (Doug Magedman)
- Using Systems Thinking in Cross-functional Teamwork to Create Innovation (Julia Taylor)
- Systems Engineering Validation of Legislative Statutes: Structural Analysis of Pennsylvania Statutes, 2012 Legislative Session (David Schrunk and Maria Romero)
- Demonstrating Resilience as Systems Engineers (Sri Harsha)
- PyML Open Source System Modeling Library Introduction (Ray Madachy)
- Law System Use Case Modeling (Ray Madachy)
- Leaving No One Behind in Naval Digital Transformation (Chelsea Ballinger)
- Systems Engineering and Photography? You Bet! (Greg Bulla)

Learn more about the conference here. Register here.

OMG Q4 Technical Committee Meeting - Companion Events



The Object Management Group (OMG) is offering a full slate of companion events to be held in conjunction with the OMG's Fourth Quarter Technical Committee Meeting planned for Austin, Texas, USA on 5-7 December. PPI SyEN readers and systems engineering

practitioners are encouraged to investigate these opportunities for learning and engagement.

Q4 Industry IoT Consortium Member Meeting

Employees of Industry IoT Consortium member organizations may attend the Q4 Member Meeting to be held in Austin. This face-to-face event will run from 5-7 December. Beyond the Industry Working Group, sessions include:

- Cross-Consortia Keynote
- Digital Transformation Enablers
- Innovation Working Group: Augmented Reality
- Vocabulary Task Group

Register here.

Q4 Digital Twin Consortium Member (DTC) Meeting

Employees of Digital Twin Consortium member organizations may attend the Q4 Member Meeting to be held in Austin. This face-to-face event will run from 6-8 December.

Participants will have the opportunity to share ideas and collaborate in person with the leading digital twin experts in the world, including representatives from Ansys, Autodesk, Dell, GE Digital, Johnson Controls, Lendlease, Microsoft, Northrop Grumman, and others. Members may also sign up for participation in 15-20 minute Industrial Talk podcasts and have their podcast publicized through DTC social media channels.

Register here.

BPM+ Health December Workshop

BPM+ Health is an OMG-managed community initiative to improve the quality and consistency of healthcare delivery. It focuses on applying business process modeling standards to clinical bestpractices, care pathways and workflows directly at the point of care.

The workshop will run from 6-7 December in Austin, immediately following the OMG Healthcare Task Force Meeting on 5 December.

View the BPM+ Health agenda. Register here.

UAF® Tool Vendor Roadshow

The Unified Architecture Framework (UAF®) Tool Vendor Roadshow, a hybrid event on 7 December, will feature demos by tool vendors of the latest technology surrounding enterprise and system of systems architecture.

View the Roadshow agenda. Register for this free event here.

Advances in the Assessment of Software Quality & The Cost of Bad Software

The Consortium for Information & Software Quality (CISQ) will host this workshop in Austin on 8 December to present the latest international standards for measuring the structural quality of software and the cost of poor-quality software. Topics include:

- Measuring software quality, DevOps, & ISO 5055
- Cost of Poor Software Quality
- Future of Process Measurement and Improvement

Register for the free CISQ workshop. Learn more about CISQ here.

Learn more about OMG here.

Registration Opens for Reliability & Maintainability Symposium (RAMS® 2023)



Registration has opened for the 69th Annual Reliability & Maintainability Symposium (RAMS® 2023), an in-person conference that will take place on 23-26 January 2023 in

Orlando, Florida, USA. The theme for RAMS® 2023 is "*The Digital Transformation of R&M*". This theme addresses the capability for reliability and maintainability to be incorporated into digital engineering design and to be improved through the collection and timely analysis of equipment-specific field data and health monitoring systems that leverage Artificial Intelligence and machine learning.

Testifying to the significance of reliability and maintainability in the design of products and systems, the symposium is sponsored by numerous professional societies, including:

- Society of Reliability Engineers (SRE)
- Institute of Industrial and Systems Engineers (IISE)
- SAE International
- IEEE Reliability Society
- Institute of Environmental Sciences and Technology (IEST)
- System Safety Society
- ASQ Reliability & Risk Division (ASQRRD)
- ASQ Electronics and Communications Division

The symposium agenda includes approximately 70 tutorials, paper presentations or panels providing broad coverage of reliability and maintainability topics. Examples include:

- An Introduction to Probability Models in Reliability and Maintainability
- Autonomous Systems and Al
- R&M Applications in Space

- Introduction to Life Data Analysis
- Digital System Reliability and Testing
- Next Generation Fault Tree Analysis Methods
- Prognostics and Health Management
- Safety Critical Systems and Methods
- Accelerated Life Testing
- Use of Design of Experiments for Reliability Evaluation and Improvement
- Maintenance Models and Methodologies

An additional track has been added that will be dedicated to delivering ASQ Certified Reliability Engineer (CRE) Preparatory Training in sessions aligned with the same times for sessions of the regular RAMS sessions for paper presentations and tutorials.

Learn more about RAMS® 2023. Register here.

CSER 2023 Keynotes and Submissions



The 20th annual Conference on Systems Engineering Research (CSER) will take place at Stevens Institute of Technology (Hoboken, New Jersey, USA) on 16-17 March 2023. CSER, created in 2003 by the Stevens Institute of Technology and the University of Southern California, is a leading international conference for disseminating

systems engineering research and fostering discussions that generate viable new research projects.

The theme for CSER 2023 is *"Systems Engineering Toward a Smart and Sustainable World,"* emphasizing how the transdisciplinary systems engineering research community can play a pivotal role in creating smart systems and the transition toward a more sustainable society.

Keynote speakers for CSER 2023 have been announced:

- Dr. Victoria Coleman, Chief Scientist of the United States Air Force
- Dr. Rick Kazman, Danny and Elsa Lui Distinguished Professor of Information Technology Management, University of Hawaii
- Ms. Emily Kagan Trenchard, Vice President, Digital and Innovation Strategy, Northwell
- Dr. Merve Unuvar, Director, Al Platforms and Automation, Thomas J. Watson Research Center, IBM
- Dr. Kathryn W. Jablokow, Professor of Engineering Design and Mechanical Engineering, Penn State University

There is an opportunity for paper submissions through 5 December 2022. Suggested application areas include:

- Energy, environment, and transportation
- Healthcare and medicine
- New space (entrepreneurial space, emergent private space industry, etc.)
- Smart cities, infrastructure
- Urban resilience; sustainable development; and education

Learn more about CSER 2023.

NAFEMS Regional Conference: Simulation in the Automotive Industry



NAFEMS, the International Association for the Engineering Modelling, Analysis and Simulation community is hosting a regional conference in Troy, Michigan, USA on 7 December 2022. This in-person event is titled *"Simulation in the Automotive*"

Industry: Driving Convergence to Electrification, Autonomous and Connectivity". Target participants include major automotive manufacturers and suppliers who will gather in a pre-competitive manner, to exchange ideas, identify best practices, and drive the near-future direction of technology.

Keynote addresses include:

Electrification Thermal Development: Opportunities and Challenges (Dr. Yangbing Zeng; General Motors Corp.)

Thermal management is of paramount importance for electrification as the automotive industry aggressively transitions to electric vehicles. To meet range demands and reduce charging times, more battery energy is being packed into vehicles with increased charging current during DCFC. Consequently, heat generation from electric vehicles keeps rising. The development of an advanced thermal management system to keep pace with heat generation from the battery becomes increasingly challenging as the battery temperature must be within a narrow window to be efficient. Additional challenges come from protecting the battery system during the event of thermal runaway. Multiple physics analyses and simulations play an important role in overcoming these challenges while developing a thermal system. The insights gained from these simulations allow thermal engineers to learn faster and select the right technologies. The high-fidelity simulation also enables the full system to be optimized virtually to shorten development time.

Deploying World-Class Simulation across Ford Software-Defined Vehicles (Dr. Justyna Zander - Director ADAS Simulation; Ford Motor Co.)

With the arrival of software-defined vehicles, the need to virtualize every step of development became a necessity. At Ford, we are transforming software production pipelines using end-to-end simulation deployment horizontally across all software products and vertically across all platforms. The goal is to iterate fast on creating a fantastic driving experience along with a strong quality and safety compliance.

Conference tracks and presentation topics include:

Batteries:

- Electrochemistry CFD methods for effective thermal propagation and cooling evaluation
- Simulation methods for fast charging and thermal evaluation
- Methods for battery system light weighting
- System optimization balancing of thermal performance vs light weighting for best vehicle range

E-Motors:

- System level methods for evaluating e-motor efficiency and its effects across attributes
- Integration of electromagnetic evaluation methods with NVH through co-simulation for evaluating design trade-offs

Autonomous Vehicle / ADAS Simulation Technologies:

• Effective Methods for integrating Vehicle Models into ADAS application software

- Simulation technologies for Sensors, Cameras, Thermal Imaging, Radar, Lidar image, Sonar sensors
- Simulator technologies for AV Drive evaluations
- Better Pedestrian Vehicle Interaction capabilities (i.e., Driver in the Loop (DIL), Pedestrian in the Loop (PIL)
- ADS modeling for Vehicle Safety (interaction with roadside, vehicle fleet coexisting on highway autonomy, etc.)
- Connectivity simulation technology for AVs
- Traffic network modeling

A panel discussion on the topic *Simulation Solutions: Opportunities and Challenges for the Effective Delivery of Automotive Electrification and Autonomous Technologies* will wrap-up the conference.

Learn more about the conference and register here. View the conference agenda. View event abstracts here.

Upcoming INCOSE webinars

INCOSE is sponsoring two webinars in December 2022 and January 2023 that address the organizational and cultural aspects of socio-technical systems.

Organizations as Systems: Principles of Systems Thinking to Improve Organizational Performance Date: 14 December 2022

Speakers: Eric van der Meulen, Senior Consultant at Agile Change and Marcelino Sánchez, Managing Partner at Agilityze

Abstract:

Human organizations are human systems just like technical systems. The relationships, interactions, interfaces, and behaviors are all connected. Unlike technical systems, however, human systems are not 100% predictable and they tend to exhibit higher degrees of variation. During this interactive session we will explore key principles of systems thinking applied to human systems to gain insights on how to achieve desired results, better collaboration, more satisfying relationships, and sustained improvement.

Outline of Principles to Explore:

- Human interfaces: Oshry's model of human systems
- Psychological Safety: Trust, Collaboration, Innovation
- Simplification and Agility
- Systemic Reinforcement Model

Learn more and register here.

Collaborative Systems Thinking Culture: A Path to Success for Complex Projects

Date: 11 January 2023

Speaker: Raymond Wolfgang, Systems Engineer at Sandia National Laboratories

Abstract:

The world is filled with hard, complex problems seeking solutions. To make these often daunting problems more manageable to solve, both a mindset shift, and key candidate methodologies centered around a collaborative systems thinking culture are proposed. The idea is to introduce not just some collaborative practices, or systems-thinking approaches. Rather, the proposal for solving

the tough problems – complex problems that basic approaches do not seem to solve – is to move an organization beyond basic techniques into a culture that has as its core a collaborative and systems-thinking theme. This paper will present an introduction to what a collaborative systems thinking culture (CSTC) is and looks like. The paper starts with exploring the state of the practice, presents the mindset change involved with systems thinking, propose that a collaborative approach is a part of this shift, and then conclude with the 7 phases that the reader can introduce into their organization to realize some of the benefits. What the attendee will learn, is a practical, 7-step approach to help facilitate moving their group to a more collaborative culture. Not all steps must be done at once, and the approach of course is tailorable to the attendee's situation. Cultural change can be hard, but this presentation will provide ideas and a process to get started. The intent is that with the right amount of CSTC in the organization, projects will produce results of higher quality, with better schedule and cost performance.

Learn more and register here.

Call for Abstracts: Integrate23 Conference



Vitech has issued a Call for Abstracts for 45-minute technical presentations for the Integrate23 conference to be held in Scottsdale, Arizona, USA on 5-8 June 2023. Consistent with a vision of open and connected digital

engineering, presentations should highlight technology, techniques, or methodologies that advance the state of systems engineering, Model-Based Systems Engineering (MBSE), or Digital Engineering as a whole. Case studies, how-to information, and usage tips are favored, and individual or team presentations are welcome.

Topics of interest include:

- Digital Engineering: Innovative approaches to product development, process and data continuity, digital thread, and connected engineering.
- Systems Engineering: Including architecture best practices and MBSE methods as applied to industry solutions.
- Enterprise Architecture: The latest advances in digitalization of processes, manufacturing, and more.

Presentations are encouraged from a broad range of industries such as, but not limited to, automotive, aerospace, space systems, defense, energy, industrial automation, manufacturing, construction, and medical.

Submission deadlines are:

- 31 January 2023: Abstract submission
- 7 April 2023: Draft presentations
- 5 May 2023: Final presentations

Learn more about Integrate23. View the Call for Presentations. Submit abstracts here.

Webinar on Lean Healthcare Systems Engineering (LHSE)



On 8 November, the INCOSE Los Angeles (California, USA) chapter hosted an online presentation by Bo Oppenheim to highlight the key concepts of a new Lean Healthcare Systems Engineering (LHSE) process. Oppenheim provided a historical overview of popular quality improvement methodologies and compared them against the merits of LHSE. The presentation summarized the findings of a 63-page LHSE White Paper.

Legacy methodologies included:

- Plan Do Study Act (PDSA)
- TQM =Total Quality Management
- Six Sigma
- Theory of Constraints
- Lean
- Lean 6 Sigma

Each method was described and evaluated qualitatively against a set of criteria, including:

- Strengths
- Weaknesses
- Cost and effort of implementation
- Ability to reduce system variability
- Importance of literature review
- Ability to eliminate bottlenecks
- Ability to apply rigor across the entire project
- System's approach
- Ability to Integrate across interfaces of fragmented system elements
- Ability to reduce project iterations
- Promotion of leadership engagement

Oppenheim believes that the following factors support the thesis that LHSE is superior to previous methods:

- The LHSE process has demonstrated success in over 100 projects in many healthcare institutions. LHSE has been shown to apply to all clinical environments: clinics, hospitals, EDs, ORs, clinical and imaging labs, pharmacies, telemedicine, and population health.
- LHSE does not require any engineering or math knowledge but requires logical rigor.
- Previous Quality improvement methods often presented a temptation to twist the results to show that the solution has been achieved. LHSE relies on rigorous requirements, validation, and verification.
- Traditional Healthcare projects often are short of success because no formal requirements were formulated.
- LHSE uses formal risk and opportunity analysis and mitigations absent in previous methods.
- LHSE promotes visual checklists (SIPOCS) which reduce miscommunications and facilitate coordination. Medical professions do not use such architecting tools.
- LHSE insists on literature review, which is ignored in earlier Quality methods leading to a repetition of previous missteps.

Download the LHSE presentation. SyEN readers should note the comparison summary table on slide 27.

Upcoming PPI Live-Online ™ Systems Engineering Five Day Courses

Click <u>here</u> to view the full schedule or register for an upcoming course.

P006-899-1	Europe CET 9:00 (UTC +1:00) PPI Live-Online	05 Dec - 09 Dec 2022
P006-899-2	United Kingdom GMT 8:00 (UTC +0:00) PPI Live-Online	05 Dec - 09 Dec 2022
P006-899-3	South Africa SAST 10:00 (UTC +2:00) PPI Live-Online (Only available in South Africa)	05 Dec - 09 Dec 2022
P006-900-1	Asia SGT 5:00 (UTC +8:00) PPI Live-Online	12 Dec - 16 Dec 2022
P006-900-2	Oceania AEDT 8:00 (UTC +11:00) PPI Live-Online	12 Dec - 16 Dec 2022
P006-901-1	North America EST 8:00 (UTC -5:00) PPI Live-Online	19 Dec - 23 Dec 2022
P006-901-2	South America BRT 10:00 (UTC -3:00) PPI Live-Online (Only available in South America)	19 Dec - 23 Dec 2022
P006-903-1	Europe CET 9:00 (UTC +1:00) PPI Live-Online	09 Jan - 13 Jan 2023
P006-903-2	United Kingdom GMT 8:00 (UTC +0:00) PPI Live-Online	09 Jan - 13 Jan 2023
P006-903-3	South Africa SAST 10:00 (UTC +2:00) PPI Live-Online (Only available in South Africa)	09 Jan - 13 Jan 2023
P006-904-1	Turkey TRT 8:00 (UTC +3:00) PPI Live-Online	16 Jan - 20 Jan 2023
P006-904-2	Saudi Arabia AST 8:00 (UTC +3:00) PPI Live-Online	16 Jan - 20 Jan 2023
P006-905-1	North America EST 8:00 (UTC -5:00) PPI Live-Online	16 Jan - 20 Jan 2023
P006-905-2	South America BRT 10:00 (UTC -3:00) PPI Live-Online (Only available in South America)	16 Jan - 20 Jan 2023
P006-906-1	Asia SGT 5:00 (UTC +8:00) PPI Live-Online	13 Feb - 17 Feb 2023
P006-906-2	Oceania AEDT 8:00 (UTC +11:00) PPI Live-Online	13 Feb - 17 Feb 2023
P006-907	London, United Kingdom GMT 8:30 (UTC +0:00) In-Person	20 Feb - 24 Feb 2023

Towards an Accessible Digital Thread: How Intuitive Information Retrieval Contributes to Future Systems Engineering

by

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Authored for PPI SyEN

Introduction

As INCOSE, arguably one of the most important conceptual drivers of the field of systems engineering, also envisions in their recently published vision paper on the future of systems engineering, the future society will experience a level of interconnectedness, interrelatedness and networking which was not seen before. Of course, this also poses an enormous challenge to the systems engineering techniques we use: those techniques will have to be able to cope not only with the increased complexity and expected adaptability of the systems around us, but also with representing the socio-technical system as an integrated system of systems.

At any scale and abstraction level a system model is, essentially, information, wherein the objects of the world are reflected along with their logical relations. A system model is a repository of engineering knowledge, of connections, of numerical (as well as other kinds of) data, of traces and links between engineering domains. For this information to become alive, we also need to think about adequate means for *having an integrated, holistic representation of various system domains and aspects at hand, and also for making the information encoded in the model for as many stakeholders as possible.* Support for diverse stakeholders also entails the inclusion of various modes of analytics and representation into the ecosystem.

Consequently, we, the systems engineering community as a whole, need to tackle and to provide a definition and a continuous refinement for a general technical and conceptual baseline for an *accessible digital thread*.

In the rest of the article, we revisit a case study on how systems engineering might benefit from stateof-the-art information retrieval techniques from other technical domains. The concrete field on which we present some preliminary observations is that of Natural Language Processing (NLP), as for its potential applications in the context of model-based systems engineering (MBSE). NLP, given its conceptual basis as well as the rapid technical advancement it underwent in the recent past, appears to be a very promising candidate for cross-fertilization: the general goals of semantical integration and ease of intuitive access lie at the heart of both NLP and future MBSE.

Closed-World Systems Engineering: Information Reserved for Experts

Structured querying is a technique that relies on a dedicated query language often offered by a modeling platform. Such query languages find their origin in descriptive logic (first-order logic and predicate logic) to find relevant elements in the model. The aim of such languages is the retrieval of elements (or compounds of elements, i.e., patterns) from a graph. A query engine (i.e., a module overseeing query execution and result retrieval) is in every case an integrated part of a graph-based tool offering. Sometimes, a query engine is realized for dedicated use for a given underlying graph representation and a particular query language (e.g., Cypher for Neo4j, an SQL dialect for OrientDB, etc.). There are also platform-agnostic query engines, e.g., the IncQuery Suite (https://incquery.io/), which offer support for multiple graph backends and query languages, emphasizing even more the genericity of the information retrieval task at hand. In any case, the endeavors of the query language community revolve around usability, to a large part also meaning intuitiveness, as well as query performance and domain-tailored extra features. To write a query, one has to combine knowledge on a lot of things: on modeling tools and query languages, on industrial standards used, on technical as well as business domains.

Moreover, learning a query language and applying it to address the needs of a project has a steep learning curve (cf., e.g., Mussbacher 2020, Lano 2020). This is the reason why most engineers do not use that capability of the tools and delegate that work to a few rare experts. A typical process is shown in Figure 1, where an expert is responsible for pre-writing a set of queries used by all engineers on the project. Such practice is not flexible enough and leads to accessibility bottlenecks on the modeling experts, making the benefits of MBSE enjoyable only to a few initiates.



Figure 1: Closed-World Systems Engineering: Information Reserved for Experts

A very promising way forward and therefore also our focus in the present paper, is the domain of intuitive information retrieval. This field underwent a fundamental change of perspective due to progress in Natural Language Processing. The trend clearly moved towards natural language search, i.e., a querying approach where the query is freely expressed by users in natural language, without the need to abide by a mathematical notation. To lower the complexity of mastering query languages and offer a more natural interface with models or knowledge graphs, some experiments have proposed the generation of formal queries from natural language utterances. These experiments show some important limitations regarding expressiveness and will not be explored in much detail in this paper. On the contrary, we believe and will demonstrate that textual information retrieval

methods could be applied to the more structured form of inputs such as system engineering models.





Figure 2: Open-World Systems Engineering: Understanding for Everyone

Figure 2 shows an updated version of our representation of state-of-the-art querying practice in MBSE. The key element of our new setting is that after modeling data has been (optionally) filtered or prepared via the usual methods of structured querying, we apply a model-to-text transformation on the query results to achieve model self-descriptions (MSD), i.e., natural-language (in this paper, English) documents automatically generated from query results - while retaining a trace link to the originating model elements. This concept allows us to represent those documents via state-of-the-art NLP language models, thus making them available for a wider range of professionals, not necessarily having modeling expertise, for various textual comprehension and retrieval activities; in particular, for natural querying. Here, in contrast to structured querying as usually performed in MBSE, the medium and the interface of the information retrieval process are both based on natural-language syntax and semantics, resulting in an increased accessibility for a wider range of professionals.

Natural Model Processing: An Experiment

In this section, we come to demonstrating our first experiments with applying (well-known) NLP techniques to model self-descriptions. The HSUV example (https://www.omg.org/ocsmp/HSUV.pdf) is an official demonstrative example for the SysML language. The scope of the model is to provide an abstract representation of a car, namely, a SUV (Sport Utility Vehicle) capable of switching between a conventional engine and a battery as power source. As a concrete search scenario, let us imagine someone wanting to find out more about the environmental awareness aspects of the model at hand, which is arguably a very natural search goal in a car model. This search scenario would involve an exploration of results for search terms like environment or fuel consumption.

In order to gain more insights on how language models with different semantic and contextual sensitiveness behave over MSDs, we qualitatively evaluate both:

- a TF-IDF model as implemented in Gensim: a well-known, relatively simple vector model, reflecting the importance of certain words in documents, thus, applicable in similarity-based search scenarios (cf. (Ramos 2003) for details), and
- BERT, a language model by Google and a subject of recent hype: a language model based on the Transformer deep learning model to achieve higher contextual awareness (Vaswani 2017, Devlin 2018). We use the openly available, pre-trained transformer offered by Google as part of its TensorFlow platform; see https://tfhub.dev/google/bert_uncased_L-12_H768_A-12/1

We use an intuitive set of five search terms, being definitely not exhaustive, yet diverse enough to serve as a basis of some observations. Table 1 summarizes the top five results according to BERT to each of those terms, while Table 2 does the same for the TF-IDF model. The pairs of numbers before the result documents represent the document ID and the relevance score, respectively (included for reference, but not particularly relevant in our qualitative evaluation). Note that in the case of BERT, unlike TF-IDF, a lower score indicates higher relevance.

Search term	Top 5 Results			
	(998, 0.33707714) The weather is a Weather type part property.			
environment	(991, 0.34621608) The object part property is owned by the Environment block.			
	(357, 0.35240495) The Environment block does not have any value properties.			
	(593, 0.360799) The AutomotiveDomain block does not have any value properties.			
	(746, 0.36104614) The EconomyEquation block does not have any part properties.			
	(361, 0.38415742) The Environment block has a weather part property with the type of Weather.			
environmental aware- ness	(997, 0.3849529) The weather part property is owned by the Environment block.			
	(346, 0.39008915) The Weather block is in the HSUVModel package.			
	(994, 0.3911605) The road part property is owned by the Environment block.			
	(901, 0.39734358) The temperature value property is owned by the Fuel block.			
	(1230, 0.29164267) The Port port is owned by the FuelInjector block.			
	(1304, 0.29222393) The press port is owned by the FuelFlow block.			
fuel	(1312, 0.29304463) The flowrate port is owned by the FuelFlow block.			
	(27, 0.29450905) The Wheel package contains the block.			
	(507, 0.29519367) The Fuel block does not have any part properties.			
	(993, 0.2565186) There is a road part property in the model.			
What properties do we	(898, 0.25655788) The pressure value property is owned by the Fuel block.			
store about fuel?	(996, 0.25691932) There is a weather part property in the model.			
store about juet:	(432, 0.25707555) The FuelFlow block does not have any value properties.			
	(901, 0.26040572) The temperature value property is owned by the Fuel block.			
subsystem of Hybrid- SUV	(125, 0.25454134) The HSUV Structure package contains the InteriorSubsystem block.			
	(622, 0.2562611) The InteriorSubsystem block is in the HSUV Structure package.			
	(592, 0.2611069) The AutomotiveDomain block is in the HSUV Structure package.			
	(388, 0.26409155) The HybridSUV block has a p part property with the type of PowerSubsystem.			
	(385, 0.26469934) The HybridSUV block has a b part property with the type of BodySubsystem.			

Table 1: HSUV Search Results using BERT as Underlying Language Model

Search term	Top 5 Results		
	(355, 0.95386463) There is a Environment block in the model.		
	(362, 0.9485242) The Environment block does not have any port.		
environment	(357, 0.91609514) The Environment block does not have any value properties.		
	(356, 0.7378269) The Environment block is in the HSUVModel package.		
	(81, 0.73392475) The HSUVModel package contains the Environment block.		
	(0, 0.0) There is a HSUV Specification package in the model.		
	(1, 0.0) The HSUV Specification package is in the HSUV Requirements package.		
environmental aware-	(2, 0.0) The HSUV Specification package does not have any subpackages.		
ness	(3, 0.0) The HSUV Specification package does not contain any blocks.		
	(4, 0.0) There is a HSUV Requirements package in the model.		
4	(501, 0.9324345) There is a Fuel block in the model.		
	(508, 0.92490125) The Fuel block does not have any port.		
fuel	(507, 0.8482605) The Fuel block does not have any part properties.		
n. Ne	(502, 0.6503485) The Fuel block is in the HSUV Structure package.		
	(112, 0.6460559) The HSUV Structure package contains the Fuel block.		
	(507, 0.9963838) The Fuel block does not have any part properties.		
	(501, 0.79381794) There is a Fuel block in the model.		
What manufactor do an	(508, 0.7874046) The Fuel block does not have any port.		
what properties do we	(476, 0.6349541) The Transmission block contains 2 part properties, which are		
store about juet?	the fuelReturn property with the type of Fuel and the fuelSupply property with the type of Fuel.		
	(605, 0.63273764) The ElectricMotorGenerator block contains 2 part properties, which are		
	the fuelSupply property with the type of Fuel and the fuelReturn property with the type of Fuel.		
	(374, 0.9375306) There is a HybridSUV block in the model.		
subsystem of Hybrid- SUV	(389, 0.93050283) The HybridSUV block does not have any port.		
	(1000, 0.71769166) The l part property is owned by the HybridSUV block.		
	(1003, 0.71769166) The bk part property is owned by the HybridSUV block.		
	(1006, 0.71769166) The b part property is owned by the HybridSUV block.		

Table 2: HSUV Search Results using TF-IDF as Underlying Language Model

Discussion and Future Directions

As for the concrete results in this small experiment, for the first simple (yet semantically multi-faceted) search term, *environment* reveals the fundamental difference between the two language models: while each of the top TF-IDF results contain an explicit occurrence of the word "environment", the BERT results seem to convey some AI interpretation: the top result is about the weather, which is a concept certainly connected to the environment. However, this intent of interpretation arguably leads to some misinterpretations as well: the fourth and fifth result hardly have any connection to any meaning of "environment" (if we do not take "Economy" in such a sense, but that seems a bit farfetched).

However, the advantage of a language model furbished with such an interpretative attitude becomes clear in our second example, the much vaguer term *environmental awareness*. Here, somewhat surprisingly, TF-IDF simply gave up and returned the first five documents (as seen on the document IDs). In contrast, the answers of BERT feel relevant, but, again, we should not overemphasize the appearance of seemingly contextually related concepts like "fuel temperature" in the results without having mass evidence. In contrast, searching for a simple concept, like *fuel*, with numerous occurrences in the model, leads to a solid information on the Fuel block with TF-IDF, while BERT returns a set of surprising, seemingly disconnected and irrelevant results. Interestingly, the performance of BERT is somewhat improved if we put the search term in a questioning form, *What properties do we store about fuel?* However, the results set of TF-IDF is still more consistent -- actually, surprisingly good, knowing that this model only considers similarity between the search term and the sentences based on the occurrence of words. Thus, TF-IDF is slightly mislead by the multiple meanings of the word "property" (namely, its general and its modeling senses), but the result is still satisfactory and more coherent than that of BERT. Our last search term, *subsystem of HybridSUV*, represents a search scenario with a user being aware of the model structure itself. The word "HybridSUV" is

certainly a technical name and is not likely to appear elsewhere in this form (being orthographically incorrect). Consequently, TF-IDF gives as results where this very form of the word occurs. BERT, however, goes further and is capable of matching that term to the HSUV acronym. Furthermore, the results here seem to reflect upon the search intent (the HSUV sub-structure).

Summarizing our findings in more general terms, we have seen that investigating intuitive information retrieval methods in the context of MBSE has an enormous potential in guiding the field towards adequate realizations of accessible digital threads. Recent advancements in NLP make that technology an extremely relevant candidate for providing intuitive access to the valuable information stored in system models for more and more stakeholders, for an audience much wider than catered to in conventional MBSE ecosystems – and, finally, for the whole digital society.

Acknowledgments

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About the Author



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Useful artifacts to improve your SE effectiveness

SERC Research Highlights: Digital Transformation



The Systems Engineering Research Center (SERC) is engaged in numerous research initiatives focused on exploiting Digital Transformation to meet the innovation needs of the U.S. defense community. Four recent articles highlight SERC's wide-ranging efforts in this arena.

SERC and AIRC: Enabling Innovation, Velocity and Security in the Era of Digital Transformation. This article backs up the theme that SERC is *Leveraging a Network of Expertise to Enhance Innovation for the DoD*. It provides a panoramic view of how SERC, the Acquisition Innovation Research Center (AIRC) and a network of academic institutions comprise a coalition that is delivering a research portfolio that focuses on Digital Transformation of the defense acquisition ecosystem and transitioning advances to operators in the field. The article elaborates on the contribution of four research areas:

- Enterprises and Innovation
- Models and Data
- Human Capital Development
- Digital Transformation (cross-cutting enablers)

Links are provided to enable the reader to find details on specific research initiatives in each area.

Learn more about the DOD's Digital Engineering Strategy and Data Strategy. Read the full article.

SERC Developing Simulation Training Environment for Digital Engineering (STEDE)

SERC is working with the U.S. Defense Acquisition University (DAU) to develop a simulation training environment for Digital Engineering that will increase the digital literacy of its students. STEDE is intended to provide infrastructure and example case studies that enable DAU students to interact directly with models - to navigate models, find information, and use that information to make and capture decisions directly in a modeling environment.

STEDE consists of tools to support case studies and to make exercises that link course materials to case studies readily available. In this context a "case study" is a realistic but fictitious set of system models that can help illustrate critical points about Digital Engineering. STEDE also enables a Digital Engineering "textbook" to be assembled from a collection of self-contained topical learning modules.

Read the full article. Download the report.

Furthering Digital Enginering at JPEO-CBRND

SERC is supporting the Joint Program Executive Office (JPEO) for Chemical, Biological, Radiological and Nuclear Defense (CBRND) in moving toward adopting Digital Engineering (DE) into its acquisition processes to enhance acquisition decision-making. The first phase of this research addressed methods for evaluation of the JPEO's technology portfolio in the context of an Integrated Layer Defense (ILD) concept.

A second phase of this research investigated the potential for application of Additive Manufacturing (AM) across the CBRND capability portfolio. Future research is planned to investigate AM portfolio optimization.

Read the full article. Download the report.

Modernizing Systems Engineering for Digital Transformation

This SERC report presents ideas for modeling systems engineering (SE) to advance the digital transformation of acquisition within the Department of Defense (DoD). The research sought to integrate four systems engineering focus areas (Digital Engineering, Modular Open Systems Approach, Agile Development and Mission Engineering) into a new SE lifecycle management model.

The research goals for this report included:

- Creating an integrating framework that incorporates activities in each SE domain and generates options for a management and process structure.
- Making recommendations to implement a digital environment and descriptive modeling practices
- Developing artifacts (policies, instructions and guidance, plans, lessons learned, interview narratives, technical data, etc.) for an accessible body of knowledge.
- Providing outreach to government acquisition leads, program offices, science and technology organizations and other entities.

The resulting integration framework depicts all aspects of SE in the acquisition process as continuous and centered on data, countering current SE and acquisition guidance that continues to operate with a model of linear, milestone-driven, technical and management processes. The primary findings of this research are stated below:

"As the team developed the integration framework, we came to realize first that mostly linear lifecycle mental model depictions like the 'Vee' model and the DoD's 'Defense Acquisition Wall Chart' do not promote the future vision of data and models at the core of SE. Since future systems will be 'built for change' using concepts of continuous iterative development, do the somewhat linear models of existing SE lifecycle representations still adequately guide us?"

Read the full article. Download the report.

Learn more about SERC's programs and projects.

INCOSE INSIGHT Practitioners Magazine September 2022 Released



The September 2022 edition of INSIGHT, INCOSE's Practitioner Magazine published by Wiley, has been released. Electronic subscriptions to INSIGHT are available as a member benefit to INCOSE members. Hard-copy

subscriptions to INSIGHT are available for purchase by INCOSE members for one membership year, and to the public. Join INCOSE <u>here</u>.

The issue theme is the *unique abilities of the systems engineer*. Content includes:

The Unique Abilities of the Systems Engineer by Tom McDermott and Nicole Hutchison

This article introduces the theme of the INSIGHT edition and threads together a summary of the individual articles and how they build on the theme.

Is Systems Engineering Effectiveness the Heart of Today's Employability Skills? by Nicole Hutchison and Tom McDermott.

Abstract: There are three essential and interrelated sets of personal characteristics and skills that are acquired by the most valued and effective individuals as they develop their careers.

These are (1) self-leadership and learning, (2) complex problem solving, and (3) team leadership and collaboration. These are interdependent and develop iteratively through practice in authentic work-related contexts. They are at the heart of the Helix study which was conducted by the Systems Engineering Research Center to discover the sets of proficiencies that make a systems engineer effective in their roles (Hutchison and Verma 2018). They are also at the heart of the "employability skills" so desired by today's businesses. Each of these three skillsets is supported by tools of different types and can be embedded into education and organizational learning programs. In this article we relate the development of effective systems engineers as a model for all professionals and frame a set of learning objectives that individuals and organizations can use to accelerate desired employability skills.

<u>Using the INCOSE Systems Engineering Competency Framework</u> by Clifford Whitcomb, Corina White, and Rabia Khan

Abstract: This article provides examples for using the INCOSE Systems Engineering Competency Framework in practice. Background information is summarized, competency model tailoring is explained, and four usage scenarios are presented. The usage scenarios demonstrate how employers use the framework and assessment guide. The four usage scenarios are job candidate recruitment, individual competency assessment, job description tailoring for an engineering job that needs systems engineering competencies, and job description tailoring for a systems engineering job requiring an update for model-based systems engineering and digital engineering competencies. All scenarios are based on those included in the Systems Engineering Competency Assessment Guide.

<u>A Vision for Universal and Standardized Access to Systems Competency Education</u> by Caitlyn A.K. Singam

Abstract: The interdisciplinary nature of systems engineering inherently means that the concept of a systems engineer is variable, requiring several types of expertise depending on the application sector and knowledge domain the individual is working in. However, regardless of industry or specialty, systems engineers are all unified by proficiency in a core set of fundamental competencies that allow them to understand and holistically work with systems.

These systems thinking and systems engineering competencies are applicable by being interdisciplinary and are well-suited to an increasingly globalized and interconnected world. However, views of systems thinking and systems engineering competencies as non-essential supplementary skills rather than foundational ones have meant that systems thinking and systems engineering concepts are not generally included in science, technology, engineering, arts, and mathematics (STEAM) curricula until late in the educational pathway and are not always presented in a standardized manner. Consequently, under the current approach to systems thinking and systems engineering, not all individuals who can benefit from systems thinking and systems engineering education have access to it. Those who do often face substantial variability in the quality of their educational experiences.

This article discusses existing issues relating to systems thinking and systems engineering competency education, as well as the efforts of the INCOSE SySTEAM Initiative towards addressing those issues and facilitating the integration of systems thinking and systems engineering competencies into STEAM curricula at all levels of education. Furthermore, this article presents a guiding philosophy for promoting universal and standardized access to systems competency education.

The Digital Engineering Competency Framework (DECF): Critical Skillsets to Support Digital Transformation by Nicole Hutchison and Hoong Yan See Tao

Abstract: In the US, the Department of Defense (DoD) is engaging in major digital transformation efforts to modernize the defense workforce, particularly the engineering acquisition workforce to ensure that the workforce remains technically competent. This effort was kicked off with the publication of its Digital Engineering Strategy in 2018. Digital engineering is necessary to update and support systems engineering practices to maintain a competitive advantage in data analytics, data science, computation technology, modeling, and simulation. The DoD envisions successful digital engineering transformation through the modernization of the way the Department designs, develops, delivers, operates, maintains, and sustains systems. One of the key aspects of this transformation is developing a digital engineering Research Center (SERC) with the creation of a "Digital Engineering Competency Framework (DECF)" as part of its critical digital transformation and workforce development modernization efforts. Though created in the context of the US DoD, the DECF is not intended to be a defense- or US-centric and instead provides a foundation for any individual or organization looking to embark on digital transformation. This paper provides an overview of the DECF and its potential relationships with other competency frameworks.

For the Journey to Expertise in Systems Engineering, Enhance the Path with Shu Ha Ri by Fred Y. Robinson

Abstract: This paper offers a perspective for considering enhancements to the current programs for developing systems engineering professionals, incorporating consideration for developing characteristics of expertise and mastery throughout. Shu Ha Ri represents an approach for three phases of mastery development, established in ancient practices such as some martial arts and mimicked in many current approaches: beginner > intermediate > advanced, apprentice > journeyman > master, bachelors > masters > doctorate.

Anders Eriksson's research on expertise depicts three levels of progression, naïve practice > purposeful practice > deliberate practice, building on Bloom's earlier three phases of development. However, Eriksson's model is limited to domains where the demonstration of expertise can be characterized, is well understood, and is measurable or at least objectively evaluable by existing domain experts.

Most systems engineering expert achievement certifications that exist are still relatively subjective or IKIWISI (I'll know it when I see it) evaluations by the subject's future peer experts. For a given population of experts in systems engineering, there is a shared thematic set of highly diverse experiential assessment characteristics which diverge in orthogonal dimensions from some of the earlier assessment levels.

David Epstein suggests that the power of generalists comes to play more when experts address wicked problems (those lacking a pre-ordained approach for solving) than when specialists address kind problems (the opposite). Kind problems are not necessarily easy to solve, but the route is well defined. Solving wicked problems without exemplar solutions often requires the generalist's leveraging of analogic thinking, and the recognition and possible synthesis of matchable patterns (isomorphisms) learned from diverse experience sampling of other domains, not merely relying on T-shaped or Pi-shaped knowledge.

Using the Shu Ha Ri framing presents an opportunity to consider enhancements to earlier systems engineering practitioner development stages towards excelling beyond emergence and effectiveness.

What Is the Role of a Systems Engineer in an Engineering Organization? by Richard Beasley

Abstract: This article discusses the role of a "specialist" Systems Engineer inside an engineering

focused on ensures the engineering parts integrate to achieve the objectives of the whole – and so is embedding a systems approach throughout the organization – trying to "make Systems Engineering the way engineering is done". In this type of organization all engineers need systems engineering as a core skill (which is part of them becoming T-shaped". The specialist Systems Engineer needs to be more π -shaped, with specialism in the systems approach used to inform and guide all the other disciplines which need to be integrated together. Since systems engineering is an integrating discipline the group of systems engineers must not become "just another" technical silo.

Systems Skills ... From Here to Diversity by Alan Harding

Abstract: Competency, the ability to do things, is at the heart of how systems engineers realise successful systems. Over the years INCOSE and partners have codified what this means, initially in the INCOSE UK Competency Framework (INCOSE UK 2010) later adopted globally by INCOSE and used as the basis of the INCOSE Systems Engineering Competency Framework (INCOSE 2018) which, notably, included a new area of professional skills. This article considers competency from the perspective of Diversity, Equity, and Inclusion (referred to as DEI) using a variety of sources including the recently published INCOSE SE Vision 2035 (INCOSE 2022) and a variety of competency frameworks to offer a view of how the skills and competencies of systems engineers need to evolve in the future. Five new competencies are proposed, as are opportunities to improve the definitions of five more.

<u>Systems Engineers – Value Added Product Owners</u> by Aswin Sukumaran Nair

Abstract: Agile Methodology requires specialized roles like Product Owners to act as the bridge between the business and the product delivery teams. This calls for specific skills such as a customercentric, design-thinking mindset and a good vision of the overall system, its capabilities, and the ability to provide the right information at the right time.

The primary duty of a product owner is to maintain a well-refined, prioritized backlog of work items. Systems Engineers are enabled with the right methods and tools to perform solution architecture, design synthesis, system verification, and validation. Systems Engineers have visibility into the overall system, interfaces between sub-systems, and external interface requirements. Enabled with the knowledge of Technical Processes, Systems Engineers are able to describe System Elements, their behavior, and interactions in the best possible detail. This allows them to ensure that functional and non-functional backlog items are defined in unambiguous adequate detail.

By applying their knowledge and expertise as mentioned above, Systems Engineers can effectively perform Product Owner duties and enables Agile teams to work efficiently to deliver the correct system increment at the end of each pre-defined time box.

<u>Why Mountain Bike Trails Try to Scare You Off</u> by Courtney Wright

Abstract: INCOSE Certification looks for multiple pillars of skills. Some candidates have a pillar in Systems Engineering, a pillar in other Science, Technology, Engineering, and Math (STEM) skills, and a pillar in a domain (or multiple pillars in these areas). What does that look like on an application for INCOSE Certified Systems Engineering Professional (CSEP)? How do our Certification Application Reviewers (CARs) assess it? This article goes far from the commonly discussed domains and products of systems engineering and looks at how leading a bike ride can be done better by using systems engineering principles. It concludes with whether applying Systems Engineering in such an unusual case is enough to qualify a candidate for CSEP.

Teaching Systems Engineering Practices Using Principles from Studio Art Education by Tom McDermott and Molly Nadolski

Abstract: We have created a cross-disciplinary learning program across studio art, systems thinking, and systems architecture to improve systems competencies. Previous research produced a framework for relating learning concepts across these three domains. We describe how to apply these concepts to any learning situation to increase systems competencies using systems thinking and systems engineering tools. We have applied the framework in educational settings to teach systems thinking, critical thinking, and systems engineering using a tailored classroom approach derived from studio art classes. The studio format encourages the students to build their skills across a portfolio of work focused on creating appropriate views of a system, communicating them, and gaining critical review – three core aspects of the systems thinking process. An effective systems engineer conceptualizes and solves problems, addresses stakeholder concerns, explores and composes solutions, and manages system evolution. The use of art, as embodied in systems-related tools, has proven to be an effective method for developing these skills. This article presents the framework and an example graduate level Systems and Critical Thinking class taught using the studio art approach.

Despite the title of this INSIGHT issue, *Unique Abilities of the Systems Engineer*, most authors appear to support PPI's perspective that systems engineers should not be viewed as a unique class of human beings, a race apart, but rather as practitioners of a systems engineering discipline that is applicable to all engineering challenges. This perspective has been discussed by Robert Hallligan, PPI Managing Director, in a June 2020 post titled "Systems Engineers, or Systems Engineering? – Part 1" and elaborated in a second post (Part 2) published in December 2020.

This INSIGHT issue also publishes an open letter to fellow systems engineers by INCOSE Fellow Michael Pennotti titled "*Blinded by the Light?*". Pennotti questions how that systems engineers armed with formal processes, digital engineering, agile methods, sophisticated models and a dedicated modeling language could have missed the design faults that led to fatal crashes of two commercial aircraft in 2018-19.

View the entire issue of INSIGHT Volume 25, No. 3 in the INCOSE Connect Library INSIGHT Practitioners Magazine.

Assuring Trustworthiness in Dynamic Systems Using Digital Twins and Trust Vectors



Digital twins are an integral part of digital transformation initiatives that promise the delivery of smarter, more efficient, sustainable and adaptable technology solutions to meet global challenges. If they are to be adopted at scale, digital twins must operate securely and safely and

need an understandable and interoperable model for maintaining security and safety assurance that satisfies technical, business, and regulatory stakeholders.

The Digital Twin Consortium (DTC) has published a 33-page whitepaper, *Assuring Trustworthiness in Dynamic Systems Using Digital Twins and Trust Vectors*, to help organizations design digital twins securely and safely in support of digital transformation. The whitepaper presents an understandable and interoperable model for digital twins' security and safety assurance.

The whitepaper addresses the following topics:

- A New Approach: Dynamic Trust as Foundation for DT-Based Eco-Systems
- Trust-Vector Scores
- Introduction to the Trust Vector

- Connection Profiles and the Trust Relationship Pyramid
- System Metadata
- Relationship Pyramid
- Dynamic Relationships
- Reliable Collaboration of Digital Twins (Scenarios)
- Vertical Specific Application of Trust-Vector Principle
- Conclusion and Outlook

Four steps have been identified as necessary to achieve a trustworthy and dynamic digital twin system:

- Enable communication with connection profiles
- Ensure data provenance and integrity with zero trust
- Enable business confidence through continuous assurance
- Implement trust vectors for resilient dynamic systems

Download the whitepaper.

Learn more about the DTC Capabilities and Technology Working Group.

System Dynamics Review Open Access Articles



The System Dynamics Review, published quarterly by the System Dynamics Society (SDS), often provides open access to non-members of a select set of journal articles. Two recent open access articles included:

Behavioral responses to risk promote vaccinating high-contact individuals first

Author: Hazhir Rahmandad, Associate Professor of System Dynamics at the MIT Sloan School of Management

Abstract: How should communities prioritize COVID-19 vaccinations? Prior studies found that prioritizing the elderly and most vulnerable minimizes deaths. However, prior research has ignored how behavioral responses to risk of disease endogenously change transmission rates. We show that incorporating risk-driven behavioral responses enhances fit to data and may change prioritization to vaccinating high-contact individuals. Behavioral responses matter because deaths grow exponentially until communities are compelled to reduce contacts, with deaths stabilizing at levels that oblige higher-contact groups to sufficiently cut their interactions and slow transmissions. More lives may be saved by vaccinating and taking those high-contact groups out of transmission chains earlier because the remaining groups will take more precautions while waiting for their turn for vaccination. These findings are especially important considering the need for further vaccination in many countries, the emergence of new variants, and the expected challenge of distributing new vaccines in the coming months and years.

Fons et origo: reflections on the 60th anniversary of Industrial Dynamics

Author: David C. Lane, Professor of Business Informatics at Henley Business School, England

Abstract: This paper records and reflects on the anniversary of the publication of Forrester's *Industrial Dynamics*. It considers the book from four perspectives. First, it samples the earlier publications that heralded and anticipated its publication. Second, it explores in depth some contemporary reviews, drawn from a range of disciplines. The paper then looks in detail at how the book was influenced by, and itself influenced, three neighboring areas: MS/OR, system science and the social sciences, and 'problem structuring methods'. Fourth, to further place the book in context, the paper considers in brief the varied life of Forrester himself, indicating how his experiences informed *Industrial Dynamics*.

The paper closes by recapitulating the importance of *Industrial Dynamics* as the founding publication of the system dynamics field.

The latest edition of the Review (Volume 38, Issue 3 – July/September 2022) includes two additional articles that are available to members only:

Documenting the modeling process with a standardized data structure described and implemented in DynamicVu

Authors: Warren W. Farr, Samuel D. Allen, Andrada Tomoaia-Cotisel, Peter S. Hovmand

Abstract: Documenting the process of building a simulation model is different from documenting the simulation model itself. Good model-building practice includes the discovery of potentially large sets of multimedia data. Organizing and documenting data and the process of collecting it has several advantages including: tightly linking data to its source and the timing of its discovery; separating source data from researcher inference (allowing for independent inspection); maintaining an evolutionary timeline; and easily sharing source data among participants and researchers. The topic of documenting models has been widely discussed. In contrast, this article proposes a data structure and its methods for documenting the process of building a simulation model.

An elementary mechanism for simultaneously modeling discrete decisions and decision times Author: Jiangbo Yu

Abstract: In the field of system dynamics (SD), there has been a missing set of theoretically sound techniques for explicitly modeling dynamics during discrete decision-making processes across varying levels and types of decision pressures. Purchasing a property, filing a divorce, approving a merger, imposing a tariff, and launching a war are examples of actions that have broader ramifications; in these cases, the decisions and timing of those decisions are crucial in understanding and predicting the interactions between the decision-makers and their environments. Sequential Sampling Models (SSMs) have remained commonplace in cognitive psychology (CP) for decades because of their utility in simultaneously capturing individual decisions and decision-time distributions. This article reviews existing SSM literature and proposes a generalized, elementary mechanism distilled from existing SSMs, which establishes a connection between SD and CP in the hope of benefiting both fields.

Join the SDS to gain full access to the System Dynamics Review.

Systems Engineering Benchmarking Study at Automotive OEMs & Tier1 Suppliers



3DSE Management Consulting has published a Systems Engineering Benchmarking Study at Automotive OEMs and Tier1 Suppliers. The study found that automotive industry participants face significant challenges in three areas:

- New technologies
- Increasingly complex requirements
- New ways of collaboration

Study participants, senior systems engineering leaders from 6 automotive OEMs and 6 Tier 1 suppliers, responded to a survey rating their organizations on a quantitative scale (1 = strongly disagree to 4 = strongly agree) against a set of systems engineering capabilities and also provided qualitative responses on best practices.

The systems engineering capabilities assessed were:

• End-to-end functional ownership

- Architecture driven development
- Value driven target and maturity management
- Multi-speed synchronization
- Requirement compliance and traceability
- Virtual development, integration, and testing
- Cross X continuity
- System thinking

The highest performing capability across all participants was Requirements compliance and traceability. The lowest scores were received for Multi-speed synchronization and Virtual development, integration, and testing.

Suppliers and OEMs have a nearly similar maturity in 5 of 8 Systems Engineering capabilities. The capabilities with the largest difference, "Requirement compliance and traceability", "Cross X continuity" and "Systems thinking", are at a higher maturity at suppliers.

SyEN readers are encouraged to download the whitepaper to investigate detailed analysis, best practices and overall conclusions.

Learn more about 3DSE Management Consultants.

Certified Software Quality Manager (CSQM) Training

The stated mission of the International Institute for Software Testing (IIST) is to advance the software testing and quality assurance professions by promoting and recognizing professionalism through education. IIST offers a variety of certifications and supporting courses.

The purpose of the Certified Software Quality Manager (CSQM) certification is to help establish and advance the field of software quality management as a discipline independent of the field of software testing. Individuals pursuing Software Quality Management as a career will focus on method and techniques to manage product and process quality in software organizations.

CSQM certification training addresses ten areas of IIST's Software Quality Management Body of Knowledge (SQMBOK), including:

- Managing Software Quality
- Establishing the Software Quality Assurance Function
- Verification and Validation Methods
- Software Development, integration, Release, and Support
- Configuration Management
- Project Management and Planning
- Risk Management
- Requirement Engineering and Management
- Agile Software Development Methods
- Software Measurement & Analysis

Learn more about CSQM and IIST.

SYSTEMS ENGINEERING IN SOCIETY

Expanding applications of SE across the globe

ASTM E3350-22: Standard Guide for Community Resilience Planning for Buildings and Infrastructure

ASTM INTERNATIONAL Helping our world work better The U.S. National Institute of Standards and Technology (NIST) has announced the release of the Standard Guide for Community Resilience Planning for Buildings and Infrastructure (ASTM E3350-22). Previous standards exist

to ensure that individual buildings and infrastructure systems stand up to hurricanes, earthquakes, fires or other hazards, but ASTM E3350-22 provides a consensus-based standard that considers their impact on social systems and services on a community scale.

"This guide sets forth a flexible approach for communities to develop customized, comprehensive resilience plans for buildings and infrastructure systems that include input from relevant stakeholders; consider the social, economic, and physical systems of a community; establish community-scale performance goals that encourage recovery-oriented planning; and recommend processes to implement and maintain community resilience plans over time as community priorities evolve and change."

The standard was developed by experts from NIST, other U.S. federal agencies, private industry and local governments. The standard is based on the NIST Community Resilience Planning Guide, with a six-step process that helps communities to think through and plan for their social and economic needs, their particular hazard risks, and recovery of the built environment by:

- Setting performance goals for vital social functions healthcare, education and public safety and supporting buildings and infrastructure systems transportation, energy, communications, and water and wastewater.
- Recognizing that the community's social and economic needs and functions should drive goal-setting for how the built environment performs.
- Providing a comprehensive method to align community priorities and resources with resilience goals.

The recommended process consists of the following steps:

- Form collaborative planning teams
- Evaluate the current condition of social and built dimensions of a community
- Determine community goals and objectives for built systems and hazards
- Develop plans that address performance gaps and identify solutions
- Prepare, review and approve final community resilience plans;
- Implement and maintain resilience plans.

Access ASTM E3350-22 (purchase or ASTM subscription required to download) Read the NIST announcement.

Learn more about NIST Community Resilience resources here.

SYSTEMS ENGINEERING IN SOCIETY

System Dynamics and Sustainability



According to Jesica Lopez of Lund University's Centre for Environmental and Climate Science, the 2022 International System Dynamics Conference addressed, in multiple presentations, the need for "integrative approaches to support transitions towards sustainability in general and the United Nations 2030 Agenda Sustainable

Development Goals (SDGs) in specific. The acceleration and practice of systems thinking and modeling are fundamental for this and an increasing understanding of complex dynamical behaviors is at the roots of applied sustainability science."

Two such models were highlighted:

Functional Enviro-economic Linkages Integrated Nexus (FeliX)

The FeliX model simulates the complex interactions among 10 global systems to project future performance against indicators associated with 9 SDGs:

Global Systems	Sustainable Development Goals		
Population	Food (SDG 2)		
Education	Health and well-being (SDG 3)		
Economy	Quality education (SDG 4)		
Energy	Clean energy (SDG 7)		
Water	Economic growth (SDG 8)		
Land	Responsible consumption and production (SDG		
Food	12)		
Carbon cycle	Climate action (SDG 13)		
Climate	Life on land (SDG 15)		
Biodiversity			

FeliX has been used to compare the outcomes associated with five future global scenarios (development pathways) that span the 2015-2100 time frame:

- Green Recovery
- Business as usual
- Fragmented world
- Inequality
- Fossil-fueled development

Integrated Sustainable Development Goals (iSDG) model

The Millenium Institute's iSDG is a policy simulation tool that helps policymakers and stakeholders to make sense of the immense complexities of the SDGs. The iSDG model explores sustainability aspects while simulating the impact of multiple policies that affect environmental, social, and economic factors.

To learn more about the application of system dynamics to global sustainability, read the original System Dynamics Society post.

FINAL THOUGHTS FROM SYENNA

Dear Reader,

Forgive me for enjoying a couple of rants this month, but they each have a serious point to make about Systems Engineering (SE).

Rant 1: the apostrophe catastrophe

The apostrophe is famously misused. I am constantly reminded of this as I read signs outside shops and restaurants. One that I saw recently read:

"Two-course lunch 9.95 Euros. Dog's dinner's included". Possible interpretations:

- 1) The dog's dinner is included correct usage if you only have one dog
- 2) The dog's dinners are included assuming the 2nd apostrophe is spurious, this is OK for one dog that has more than one dinner or visits on more than one occasion
- 3) Dogs' dinners included ignoring the 2nd apostrophe once again, this would be applicable to more than one dog.

Whoever specified the rules for the apostrophe should be removed from office (presumably post mortem). The same symbol is used to denote three different concepts:

- Omission
- Possession
- Plurality

To make it worse, we then need intricate rules for plural nouns (the children's teacher) and for names that end in "s" (Samuel Adams' role in US history). Language moves on, and these rules must be ready for the scrap heap.

So how is this relevant to SE?

I suggest that your requirements writing guide (which is an ambiguity reduction tool) bans the use of the apostrophe. Any statement that includes one or more apostrophes should be re-written to make its (please not it's) meaning clear. Example: "The dog's hair" might become "The hair of the dog".

Which leads me on to Rant 2:

Rant 2: the font disaster

My personal email address happens to begin with the letter "L" for Lima. I often get people complaining that emails to me bounce back with an error message. The reason is that they start the address with an "I" for Indigo. The reason: a font disaster. Take a look at the table below.

	Calibri font	Arial font	Lucida Sans font	Comic Sans MS
Upper case Indigo	Ι	1	1	I
Lower case Indigo	i	i	1	i
Upper case Lima	L	L	L	L
Lower case Lima	1	Ι	L	L

FINAL THOUGHTS FROM SYENNA

In 3 out of 4 cases (and I worked hard to find the 4th), the symbol for Upper case Indigo is identical to that for Lower case Lima.

Surely Rule No.1 for a font design reads "Each character shall be readily distinguishable from all other characters". The font designers should join the apostrophe designers on the list of the unemployed, post mortem or otherwise. I'm also thinking that one person, or a small team suffering from group-think, must have designed a lot of the fonts we use. Otherwise how could two people or teams independently make the same profound error?

Could this issue cause real problems on SE projects? Surely our Verification and Validation processes would catch such obvious mistakes early on? Unfortunately, there are plenty of examples of project disasters caused by analogous scenarios.

To be fair I don't know of a real example about the font disaster, other than my email problem, but there may be one waiting to happen. Maybe there is a databus system with 12 ports labelled A to I? Which messages will go to port I, and which to port I? Try explaining the following requirement to somebody who is not familiar with the works of Jonathan Swift or the Metric measurement system:

"The system leakage shall be no more than 1 Illlputian millilltre per hour".

And how about a UK ring measurement tool:

As intended:

As plausibly implemented due to the font disaster:

What should go into our Requirements Writing Guide to avoid such issues? Rules on which fonts can be used? Rules on upper case versus lower case letters? Are there any other transgressions of Rule No.1 in the fonts that you use?

I don't have a good answer, but thanks for letting me get this off my chest.

Syenna

