PPI SyEN

SYSTEMS ENGINEERING NEWSJOURNAL EDITION 109 | FEB 2022

Progress Toward the Vision

REFLECTIONS ON INCOSE IW2022
Highlights, milestones, and new records

WORKING GROUP HIGHLIGHTS AT INCOSE IW2022
Working group and special interests sessions

SYSML V2 STATUS UPDATE
Objectives, history and key elements

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PPI SyEN

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WELCOME

Hello friends of PPI,

The theme of this month's edition is 'Progress Towards the Vision,' the systems engineering vision, of course. On the back end of the International Council on Systems Engineering (INCOSE) International Workshop held at the end of January 2022, it is clear to us at PPI that there are so many encouraging activities going on that are positively shaping the way that we go about the engineering of systems. This is evidenced by the exciting changes in the leadership of major systems engineering and related organizations, the recent release of the INCOSE 2035 Vision, and the creation of valuable work products in development in INCOSE and other influential societies such as the Institute of Electrical and Electronics Engineers (IEEE) and the Product Development and Management Association (PDMA). In addition, the long-awaited MoSSEC ISO 1303:243 standard was just released in December 2021! This standard covers application guidelines on modeling and simulation in a collaborative systems engineering context. It goes without saying that collaboration is a major area of weakness in our current systems engineering tools. This edition of PPI SyEN provides a status update on all of the above.

Conference happenings currently also support the notion that the path to the future is being paved with exciting and very relevant activities that will be critical to the future of our sociotechnical systems. Find out information pertaining to the latest about system dynamics courses and conferences. If you've been wanting to present at a conference covering Systems of Systems (SoS), IEEE invites you to submit a paper for this purpose for its upcoming SoS conference. Understanding SoSs is a critical part of the solution for effective engineering in a digitized and interconnected future. Smart systems are often underpinned by SoS properties.

The Feature articles in this edition focus on some of the takeaways from the International Workshop (IW) including some general highlights and feedback from various working group activities. In this section also expect to find out more about SysML V2, which is currently receiving a lot of hype - and for good reason!

We point out some juicy resources in this edition including books about systems engineering as applied to artificial intelligence, organizations of interest that you may decide to explore, and multiple guides that are of interest to enable you to conduct more effective engineering. We hope that you enjoyed this edition and we look forward to seeing you for the March edition!

Regards

René

Managing Editor, PPI SyEN

A Late Announcement in view of the Russian Invasion of the sovereign country of Ukraine

Effective immediately, PPI will no longer accept training and consulting business from parties with a .ru email address or a Russian physical address. Access to PPI's Systems Engineering Goldmine will also not be available. Equivalent existing accounts will be placed on hold until peace under a democratically elected government is restored in Ukraine.

Robert J. Halligan
Director

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.

SYSTEMS ENGINEERING NEWS

Recent events and updates in the field of systems engineering

INCOSE 2022 New Officers - Election Results

On the 29 January 2022, the following individuals were sworn into their new positions on the INCOSE Board of Directors (BOD) at the INCOSE International Workshop.

President-Elect (2 years / 2 years President): Ralf Hartmann

Ralf Hartmann was previously the INCOSE Director for Strategy from June 2008 - June 2015. He was the Vice President of Satellite FVI, Engineering Tools & Control Ground Segment at EADS Astrium for over 30 years then went on to become the VP of Digital Design, Manufacturing, and Service for Airbus for 4 years. Ralf currently runs his own consultancy, ProSys.

Treasurer (2 Years): Mike Vinarcik

Mike Vinarcik has had a very active career working for Ford Motor Company for over 18 years as a Laboratory Engineer, Test Engineer, Quality and Reliability Engineer, Six Sigma Black Belt and many other roles. Mike then went on to be the Lead Senior Systems Engineering at Booz Allen Hamilton for almost 10 years, served as Adjunct Professor for 17 years at the University of Detroit Mercy, and now serves as Chief Digital Engineer at SAIC. Visit Mike's LinkedIn page for a full overview of Mike's engineering career.

Director for Marketing and Communication (3 years): Honor Allison Lind

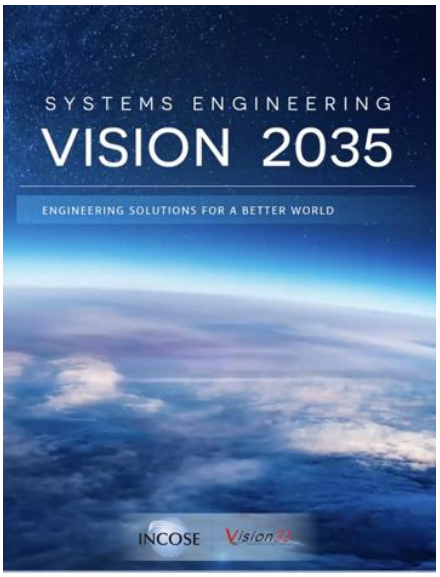
Honor Allison Lind has served a wide range of marketing and communications-related roles incuding Director of Marketing and Public Relations, Principal Consultant. Director of Sustainability and Outreach, Director of Advertising and Multimedia Sponsorship Business Development, Business Development Programmatic Digital Marketing at a multitude of organizations including the Savannah Symphony Orchestra, the Institute of Industrial and Systems Engineers (IISE) and Arts-related organizations.

Americas (Sector I) Director (3 years): Renee Steinwand

Renee Steinwand has had a flourishing career as a systems engineering practitioner and systems analyst, currently serving 32 years as a Systems Engineer at Booz Allen Hamilton. Renee is a Certified Systems Engineering Professional and active as a Systems Engineering Certification Instructor.

We would like to congratulate Ralf, Mike, Honor Allison, and Renee on their election and wish them the best as they step into their new roles. We believe the future of INCOSE is in good hands with these additions to the BOD.

INCOSE Releases its Systems Engineering Vision 2035

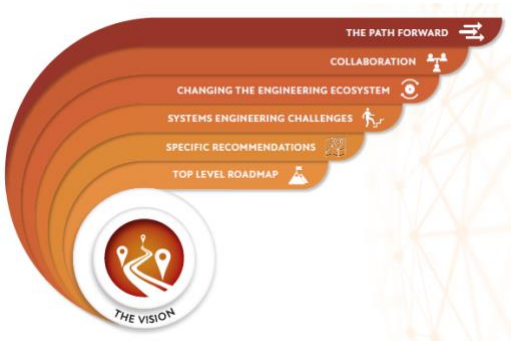


The Vision is intended to inspire and guide the strategic direction of systems engineering for the global systems community. This community includes leaders of organizations, practitioners, students, and others serving this community that includes educators, researchers, professional organizations, standards bodies, and tool vendors.

Chapter 1 provides the global context for systems engineering. It summarizes some of the key trends and influencing factors that are expected to drive changes in the practice of systems engineering. These factors include: the societal and environmental condition, technology, nature of systems, stakeholder expectations, enterprises and the workforce.

Chapter 2 highlights the current state of systems engineering including systems engineering competencies, practices, foundations, and current challenges. It points out that basic elements of systems engineering apply to all kinds of systems, small and large, and that there is significant variation in maturity across industries and organizations.

Chapter 3 describes the future state of systems engineering needed to address the changing global context and the current challenges. The chapter addresses digital transformation and the direction towards a fully model-based systems engineering environment. It touches upon theoretical foundations, and the education and training needed to develop the competent systems engineering work force of the future. The chapter also provides an example of how the daily life of a systems engineering practitioner could look in 2035.



Chapter 4 describes what is needed to realize the vision. The chapter identifies a set of systems engineering challenges, and the high-level roadmaps needed to transition systems engineering from the current state to the future state. It also highlights the need for collaboration within the global systems community to evolve and implement the roadmaps.

Overall, SE Vision 2035 is brilliantly written and produced, the kind of document that could be placed before any CEO in support of a business case to implement systems engineering in an enterprise, or to move to the next level of systems engineering implementation. The Vision itself does not provide the data that makes a strong business case; that is why we (PPI) suggest a supporting role to a business case for SE Vision 2035.

The team that developed the SE Vision 2035, sponsored by the INCOSE Board of Directors, included:

- Christopher Davey Ford Motor Company
- Sanford Friedenthal (Lead) SAF Consulting
- Sky Matthews,IBM
- David Nichols, NASA/Jet Propulsion Laboratory California Institute of Technology
- Paul Nielsen, Carnegie Mellon University Software Engineering Institute
- Christopher Oster, Lutron Electronics
- Taylor Riethle, Graphic Designer
- Garry Roedler, INCOSE
- Paul Schreinemakers, How2SE

- Emma Sparks, Cranfield University
- Heinz Stoewer, (CTO) Space Associates and Delft University of Technology

The Systems Engineering Vision 2035 is offered by INCOSE as a community service. INCOSE's intention is to stimulate the world's systems community to think creatively about future developments in the systems and related fields. Widest use of the document is encouraged, including reproductions, translations and adaptations, with minimal restrictions. These restrictions are carried on the document.

The full document (76 pages) and an executive summary (12 pages) may be downloaded here.

PDMA Announces 2022 Board of Directors

Following officer elections in January, the Product Development Management Association (PDMA) is proud to announce the PDMA Board of Directors for 2022. Mark Adkins will lead PDMA as Chair for 2022 and 2023. Mark is the CEO of Lean Med, a medical device company dedicated to bringing essential treatment to underserved regions through innovative technologies. Mark is also the founder & president of Smart Hammer Innovation. Mark has served PDMA in a variety of capacities over time, most recently as Vice-Chair and Chapters VP.

The Executive Committee will consist of:

- Board Chair: Mark Adkins - LeanMed LLC
- Vice-Chair: Susan Penta - MIDIOR Consulting
- Secretary-Treasurer: Marlon Hernandez – Molson Coors

2022 Directors include:

- Gloria Barczak - Northeastern University
- Ludwig Bstieler - University of New Hampshire
- Greg Coticcia - Sopheon
- Rolando Cruzado - Conservation X Labs
- Nariman Lotfi - The German University in Cairo
- Luigi M. De Luca - Cardiff University Business School
- Michael O'Connor - Medtronic Corporate Science and Technology
- Wayne Fisher - Rockdale Innovation
- Charlie Noble - University of Tennessee at Knoxville (ex-officio/JPIM)

View photos and bios for the whole board here.

IEEE TEMS President's Message

Ravikiran Annaswamy, President of IEEE Technology and Engineering Management Society (TEMS), released a message to the IEEE TEMS members. Ravikiran acknowledged the formation of the society in 1951, the transition to the Technology Management Council (TMC), and the transition again to the Technology Engineering Management Society in 2017 (now TEMS). Ravikiran describes the last five years as essential for establishing a sustainable society. The next five years are critical to scaling up and expanding the impact of TEMS, in line with its 'Leaders Enabling Projects/Services Success for Good' in the tagline.

Ravikiran states explicitly the following six key initiatives that will be the focus of TEMS during his presidency:

- Recording history of TEMS: Knowing and appreciating all the achievements from past leaders will motivate us to set new directions.
- Engaging students: Getting students to understand and appreciate the management aspects of technology will help them in their careers and forge a stronger relationship with the society
- Going global: membership is global, but the value is local. We want to strengthen and empower section chapters and student chapters to engage at all levels. Diversity and inclusivity will be our focus as we expand.
- Leadership pipeline: Several eminent professionals have volunteered and led the society in these years, but going forward we are looking at defined succession plans and creating a pipeline of new leaders who get groomed for leadership roles
- Awards and Recognition: We will initiate new awards for leaders and experts in TEMS areas of interest and provide a platform for recognizing talent and innovations
- Create new revenue streams and strengthen existing finances through new products in publications, education, conferences, and an enhanced member base.

If you'd like to volunteer as part of the organization or become a member, please visit the following link.

A Look at INCOSE Working Groups

Much of the value that INCOSE delivers to its members and to the engineering community in general is via its Working Groups (WGs), currently numbering 47. These WGs conduct projects, develop resources, conduct events, and contribute to overall INCOSE initiatives. A review of the INCOSE WGs and their relative memberships is revealing. See the table below for the top 20 working groups by membership as a percentage of the total INCOSE membership.

Working Group	Percentage
MBSE Initiative (a group, but not strictly a Working Group)	8.3%
Requirements	7.9%
Agile Systems and Systems Engineering	6.7%
Architecture	4.1%
System of Systems	3.8%
Lean Systems Engineering	3.7%
Product Line Engineering	3.1%
Transportation	2.9%
Systems Security Engineering	2.8%
System Safety	2.7%
Complex Systems	2.7%
MBSE Patterns	2.5%
Integration, Verification & Validation	2.5%
Healthcare	2.4%
Automotive	2.3%

PM-SE Integration	2.3%
Human Systems Integration	2.3%
Risk Management	2.3%
Digital Engineering Information Exchange	2.0%
Defense Systems	2.0%

Table 1: Top Twenty INCOSE Working Groups by Membership

A word that first comes to the writer's mind in reviewing this list is diversity. Also significant is the relative membership of the various application domain-based WGs, the largest being Transportation, then Healthcare, then Automotive, with Defense coming in a distant fourth. The evidence points to the days of Defense dominance of systems engineering as being history.

The data also suggest that individuals join WGs to gain and/or influence cross-cutting capabilities more than for industry-specific or technology-specific adaptations of SE practices. The top seven WGs are all about general SE capabilities/disciplines.

Our feature articles in this edition will focus on the efforts of INCOSE WGs as observed and reported at the INCOSE 2022 International Workshop. Readers are encouraged to identify and engage with WGs that are tackling initiatives and developing resources that can help them grow their systems engineering capabilities, both as individuals and as organizations. If you are not an INCOSE member, you may investigate membership here.

Additional INCOSE Working Groups are listed in Table 2.

Working Group	Percentage
Space Systems	1.9%
Competency	1.8%
Tools Integration & Model Lifecycle Management	1.8%
Decision Analysis	1.7%
Systems Science	1.7%
Small Business Systems Engineering	1.6%
Artificial Intelligence Systems	1.5%
Systems and Software Interface	1.5%
Enterprise Systems	1.4%
Resilient Systems	1.4%
Configuration Management	1.2%
Infrastructure	1.1%
Object-Oriented Systems Engineering Method (OOSEM)	1.1%
SE Tools Database	1.0%
Smart Cities Initiative	1.0%
Knowledge Management	1.0%
Power & Energy Systems	1.0%
Training	1.0%
Measurement	0.9%

Critical Infrastructure Protection and Recovery	0.8%
Social Systems	0.8%
Natural Systems	0.7%
Professional Competencies & Soft Skills	0.7%
Process Improvement	0.6%
SE in Early Stage Research & Development	0.6%
Telecommunications	0.5%
Systems Engineering Quality Management (SEQM)	0.3%

Table 2: Remainder of INCOSE Working Groups by Membership

MoSSEC ISO 1303-243:2021 Standard Published

MoSSEC ISO 1303-243:2021 is now a published International Standard as of December 2021. MoSSEC is the Industrial automation systems and integration — Product data representation and exchange — Part 243: Application protocol: For modelling and simulation information in a collaborative systems engineering context standard.

The following are within the scope of this standard:

- the representation of the collaborative understanding of the requirements and their verification;
- the representation of the elements that together comprise a set of "results" for a study including the audit-trail of what is to be done, and what has been done, and evolution;
- the representation of the definitions of models and key values that are part of the modelling;
- the representation of information concerning organization and person in those organizations;
- the representation of properties and documents;
- the representation of a collaborative package of work that is launched to drive the evolution and maturity of something;
- the identification of a breakdown of something, the identification of the elements that comprise a breakdown, the parent-child relationships between breakdown elements and the identification of relationships between elements in different breakdowns;
- the representation of interfaces including connections, ports and definitions;
- the identification of which breakdowns, interfaces and models are included in an architecture;
- the representation of key values as distributions enabling the representation of uncertainties;
- the representation of justifications, assumptions and approvals to aid and record decision making;
- the representation of information used for security and trust so each organization is then to be able to enforce their own human resources and security policies.

A discussion and illustration of the scope is provided in Annex G of the standard.

The following are outside the scope of the standard:

- the detailed format and content of the modeling and simulation data;
- specific business processes.

ISO 10303-243 is agnostic of the type of modeling and simulation and the subsequent model data.

You can find information about MoSSEC on the ASD Strategic Standardization Group website and the MoSSEC Project site.

The INCOSE Tool Integration and Modeling Lifecycle Management (TIMLM) Working Group has given several presentations on the development of the MoSSEC standard at several INCOSE International Workshops and Symposiums over the past few years. If you are an INCOSE member, you can access to these files on the TIMLM Yammer Site.

The standard can be purchased on the ISO website (here).

PDMA Global Student Innovation Challenge Winners

The Product Development Management Association (PDMA) has announced the three winning teams in its 2021 Global Student Innovation Challenge. Winners were chosen based on voting at PDMA's Virtual Innovators Conference and Research Forum in January. A total of 19 teams, comprised of 79 students, representing 13 universities across 9 countries, participated in this event.

First place went to the Uvisa Health team from the Danish Technical University. Uvisa is on a mission to offer non-pharmacological solutions to intimate health issues. Their Minimum Viable Product (MVP) is a home treatment device for vaginitis. See presentation here.

Second place went to the Second Wind team from Duke University (USA). Their PositionAir solution focuses on providing patient positioning treatment for Acute Respiratory Distress Syndrome (ARDS). See presentation here.

In third place was the GoPump team from the Technical University Berlin. Their solar-powered GoPump solution helps farmers who need to supply water to crops when and where expensive traditional irrigation technologies (diesel-powered or on-grid) are out of reach. See presentation here.

The deadline to submit a project for this year's Global Student Innovation Challenge is 30 June, 2022. Details are here. Submit here.

PDMA SPARK Innovation Research Initiative

The Product Development Management Association (PDMA) is sponsoring an innovation initiative aimed at growing a community of innovation scholars. The SPARK (Stimulate Projects and Research Know-How) Program is designed to create continuous opportunities by organizing various events and forums to promote research, networking, and peer support for innovation researchers worldwide.

Early career scholars who completed their Ph.D. in the last 3-5 years are eligible to participle in SPARK.

Submissions are sought in two categories:

- A 30-minute research presentation
- A 2-minute research idea pitch.

Submissions should address topics concerning digital technologies that enhance current human capacities (e.g. mobile technologies, internet of things, big data & AI, robotics & automation, blockchain technology, gene editing & gene therapy and other products involving digital technologies, entrepreneurship).

Send submissions to spark@pdma.org by 31 March, 2022 to be considered for the first SPARK seminar, an online event scheduled for 13 May, 2022.

Details here.

PDMA Survey: Roadmapping Field Study

The Product Development Management Association (PDMA) announces the opportunity to participate in a survey concerning the use of roadmapping as a standard methodology in strategic and technology planning.

This survey, sponsored by Sven Schimpf of the Fraunhofer Group for Innovation Research, Rob Phaal of IfM Cambridge, Olivier de Weck of MIT and Thomas Abele of TIM Consulting, is an update to a first study conducted in 2015. The survey seeks to understand the current status of the roadmapping practice and tools in industry. Organizations with roadmapping experience are requested to participate in the 26-question survey here.

PPI News: Systems Engineering Tools Database (SETDB) Working Group Wins Product of the Year 2021 at the INCOSE IW

PPI's Managing Director, Robert Halligan, and Senior Engineer, René King, were pleased to receive the Product of the Year award in 2021 along with SETDB WG Co-Chairs John Nallon and Stephane LaCrampe at the IW held in Torrance, California in 2022.

The certificate states: 'The INCOSE SETDB Working Group in Partnership with Project Performance International (PPI) under a Memorandum of Understanding, developed and published the "INCOSE/PPI Systems Engineering Tools Database (SETDB)" to provide our stakeholders with current information regarding systems engineering software tools and cloud services. The SETDB provides the systems engineering community a reliable source of information about software tools they are using or wish to use while executing their business processes throughout a product lifecycle. The SETDB working group applies systems engineering and good project management to great effect and subsequently delivered a product and service of high quality and high value to INCOSE's stakeholders.'

Well done to the SETDB team!

FEEDBACK ON PPI TRAINING

We needed something potentially useful to readers in this space!

"The course provides an excellent background in understanding systems engineering overall. Personally, I found the course to be very useful in understanding the root cause of problems we often encounter in complex projects. Putting all the tools into action will be my next step!" – *Delegate, Argentina*

"The training has very much contributed to where I am in my career right now... I am now capable of developing a vision and roadmap for the future, and being a sparring partner with others in the industry regardless of level or expertise" – *Delegate, Australia*

CONFERENCES, MEETINGS & WEBINARS

Events of relevance to systems engineering

Submissions Deadline and Scholarships for 2022 International System Dynamics Conference

The System Dynamics Society reminds potential presenters of the looming 18 March deadline for submissions for the 2022 International System Dynamics Conference, to be held on 18-22 July, 2022 in Frankfurt and online. See submission instructions for details.

The System Dynamics Society has announced the availability of scholarships to defray registration fees for the Conference and associated Summer School (held online two weeks before the annual conference).

The Barry Richmond scholarship award, a $1000 cash stipend given by isee systems, is also available to a deserving practitioner whose work demonstrates a desire to expand the field or to apply it to current social issues.

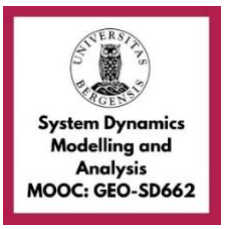
Student Chapter Conference and Summer School scholarships are available for current students and recent graduates.

See details and scholarship applications.

University of Bergen offers free online System Dynamics Courses

System Dynamics helps explain how change takes place, why people misunderstand change, and why so many policies fail to solve problems. The method builds on a systems perspective where system parts influence each other and where knowledge from different fields of study are needed.

The University of Bergen is offering two free online courses that teach the fundamentals of the System Dynamics method. These Massive Open Online Courses (MOOC's) are designed to deliver master's level understanding of System Dynamics and its application to a variety of socio-technical systems. Both courses are self-paced, taught in English and will be offered in spring (1 February – 20 May) and fall (1 September – 15 December) semesters of 2022. Students may register and start learning immediately at any time within the spring or fall semesters. Students may complete a 5-hour exam, subject to University of Bergen requirements, to earn master level credits.



The System Dynamics Modelling and Analysis course teaches the basics of the System Dynamics method. Students learn to recognize typical problem behaviors of dynamic systems, exemplified by global warming, over-utilization of natural resources, epidemics, and price fluctuations. These are all problems of importance for the UN's Sustainable Development Goals. Students learn to formulate hypotheses for why problems develop, and they learn to represent their hypotheses in simulation models and use the models to test their hypotheses. For models that give likely explanations of problem developments, students learn to formulate and test alternative policies in the very same models. Register here.

The Natural Resources Management course is application-focused, using System Dynamics to build a solid understanding of how natural resources develop without and with human harvesting. The course helps students develop the skills and competencies needed for proper management of water reservoirs, fisheries, animal herds, and climate, and for proper dealing with product and quota markets. Topics are system descriptions, dynamics, economics, uncertainty and policy design. For management of commons problems, central topics are competitive games, regulation, and market-based institutions. Register here.

Call for Papers: IEEE System of Systems Engineering Conference

IEEE System, Man, and Cybernetics Society announces the 17th International Conference on System of Systems Engineering (SoSE) to be held in Rochester, New York, USA on 5-9 June, 2022. The conference theme is "AI and Machine Learning in System of Systems". Papers on theories, methodologies, and applications of System of Systems Engineering in 30+ tracks related to science, technology, industry, and education are welcome. The deadline for online paper submissions is 15 March.Invitations will be made to the authors of the best papers to submit an extended version of papers to the following journals or book chapters for the CRC Taylor & Francis SOSE Book Series:

- IEEE Systems Journal
- Journal of Enterprise Transformation
- Journal of Smart Health and Smart Cities
- CRC Taylor & Francis Books Series on SoSE, Mo Jamshidi, Editor

See more details here. Download the Call for Papers.

Early Registration Opens for IISE Annual Conference and Expo

The Institute of Industrial and Systems Engineers (IISE) has opened early registration for the IISE Annual Conference and Expo 2022 to be held in-person in Seattle, Washington, USA on 21-24 May.

Keynote speakers include:

- Pinar Keskinocak: William W. George Professor and Chair in the School of Industrial and Systems Engineering, Georgia Tech
- Alexis DePree: Chief Supply Chain Officer, Nordstrom Inc.
- Gregory Hyslop: Chief Engineer, Executive Vice President, Engineering, Test & Technology, The Boeing Company

Learn more. Register here. Join the IISE.

Lecture: Cost-Effectiveness Analysis - A Systems Engineering Perspective

The INCOSE Chesapeake Chapter is hosting a talk by Dr. Howard Eisner on Cost-Effectiveness Analysis: A Systems Engineering Perspective on 16 March 2022. Dr. Eisner is professor emeritus at George Washington University (GWU), an INCOSE fellow, a life fellow of IEEE and the author of twelve books relating to engineering, management, systems, and, of course, systems engineering.

From the INCOSE Chesapeake Chapter website:

This presentation will focus upon cost-effectiveness analysis (CEA) as systems engineers are looking for cost-effective solutions; CEA is a proven method for choosing the best answer from a set of alternatives; a brief look at examples from the military as well as from everyday consumer decisions; three solution domains are recognized explicitly: low cost, low effectiveness, knee-of-the-curve, and high effectiveness, high cost; the role of cost-effectiveness in systems architecting is explored; this approach leans on Rechtin's KISS heuristic.

Register for the free lecture here.

Life Cycle Modeling Language MBSE Conference

The second annual Life Cycle Modeling Language (LML) Model-Based Systems Engineering Conference (MBSE-CON) is taking place virtually on 15-17 March, 2022. The conference is aimed at professionals and government officials interested in expanding systems engineering to a data-driven model-based solution. It is also targeted at academics that would like to stay up to date with the current usage of MBSE or make use of it in the classroom.

This year's focus is on the pillars of lifecycle modelling: cost, performance, risk and schedule.

Attendees will receive (in addition to presentations from over 25 experts in MBSE):

- A free membership to the LML organization for a year.
- Daily social activities including morning yoga and mindfulness with certified yoga instructor, mixology class, happy hour trivia, and prizes
- A unique networking experience to educate yourself at sponsor booths, interact with other attendees, or attend speaker sessions.
- A free copy of the LML Specification book (digital copy).
- The opportunity to attend our workshops to learn more about MBSE and LML.
- Over 25 MBSE experts, providing you and your team with valuable insights.
- Swag Box from sponsors (only for the Americas).
- Free LML Certification Testing.

View the schedule for the conference or register for the conference here.

Workshop: Building the NIST AI Risk Management Framework

The U.S. National Institute of Standards and Technology (NIST) continues its development of an Artificial Intelligence (AI) Risk Management Framework (RMF). Building on the AI Risk Management Framework Concept Paper produced after an initial workshop in October, 2021, NIST has planned a second online workshop for 29-31 March.

The Framework aims to foster the development of innovative approaches to address characteristics of trustworthiness including accuracy, explainability and interpretability, reliability, privacy, robustness, safety, security (resilience), and mitigation of unintended and/or harmful bias, as well as of harmful uses.

NIST will release a first draft of the Framework in advance of the event where AI experts and stakeholders across sectors will further advance the guidance document. The first two days of AI RMF Workshop #2 will address all aspects of the AI RMF; day 3 will take a deeper dive into issues related to mitigating harmful bias in AI. The workshop will consist of multiple panels and robust online forums from 11am-4pm EST each day.

For more information about the Framework, visit the NIST AI RMF website.

Register for the AI Risk Management Framework Workshop #2 here.

Arcadia-Capella Online Training in March

Obeo is offering Arcadia and Capella training on 21-28 March, 2022. The course will be delivered by a Thales MBSE expert, in English, through 6 sessions of 3.5 hours each. To take advantage of this opportunity to learn how to use effectively the open-source tool Capella and the Arcadia MBSE method, please contact sales@obeosoft.ca for pricing and registration.

PPI RESOURCES

PPI offers a multitude of resources available to all of our clients, associates and friends! Click on any of the links below to access these resources today.

Systems Engineering FAQ: https://www.ppi-int.com/resources/systems-engineering-faq
Industry-related questions answered by PPI Founder and Managing Director Robert Halligan.

Key downloads: https://www.ppi-int.com/keydownloads/
Free downloadable presentations, short papers, specifications and other helpful downloads related to requirements and the field of Systems Engineering.

Conferences: https://www.ppi-int.com/resources/conferences-and-meetings/
Keep track of systems engineering-relevant conferences and meeting dates throughout the year.

Systems Engineering Goldmine: https://www.ppi-int.com/se-goldmine/
A free resources with over 4GB of downloadable information relevant to the Engineering of systems and a searchable database of 7,800+ defined terms. You can expect the content of the SE Goldmine to continue to increase over time.

Systems Engineering Tools Database (requires SEG account to log in from the Systems Engineering Goldmine): https://www.systemsengineeringtools.com/
A resource jointly developed and operated by Project Performance International (PPI) and the International Council on Systems Engineering (INCOSE). The SETDB helps you find appropriate software tools and cloud services that support your systems engineering-related activities. As a PPI SEG account holder, you have ongoing free access to the SETDB.

FEATURED ARTICLES

Reflections on the INCOSE International Workshop 2022

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The INCOSE International Workshop (IW) took place in Torrance, CA, USA over January 29 to February 2, 2022 and was a great success, with both physical presence and online remote participation well supported. The IW is an event at which mainly Working Groups and other INCOSE elements such as the Board of Directors and various Committees come together to work. New officers are sworn in, awards are awarded, inspiration is shared.

A highlight of this IW was the release of the INCOSE Systems Engineering Vision 2035. The purpose of Vision 2035 is to inspire and guide the strategic direction of systems engineering across diverse stakeholder communities, including policy makers, engineering and executive leadership, professional organizations, standards bodies, engineering practitioners, researchers, educators and students. The Vision is the subject of another news item in this edition of PPI SyEN.

Model-Based Systems Engineering (MBSE)

A feature of the IW was a MBSE Workshop, conducted over two days. MBSE sessions included updates on SysML v2, OPM, OSLC, and other standards, updates from DoD, SERC, CIMData, NAFEMS, SETDB, CIPR, AI4SE, Taming Dragons: Who's Your Customer, What's your problem?, When you build it & they do not come, Modeling Critical Infrastructure, Loss-Driven SE for connected AV's, Uber Allocation of system implementation options, MBSE for UAS Applications, 5 Lessons we can learn from the way other industries manage complexity, and a lot more.

Digital Engineering and Tools Integration

Digital engineering and tools integration seemed to be coming of age at this IW, with in many cases, years of work coming to fruition. A major milestone was the release in December, 2021 of the MoSSEC standard: ISO 10303-243 – MoSSEC Modelling and Simulation information in a collaborative Systems Engineering Context, otherwise known as AP-243. This standard is the subject of a separate news item in this edition.

Systems Engineering Tools Database

Walkthroughs of the jointly developed and operated PPI-INCOSE systems engineering tools database were popular, the database itself growing by about 25 tools during the course of the IW.

INCOSE Systems Engineering Handbook 5th Edition

Many working sessions were conducted by the team developing the new, 5th Edition of the handbook. This new edition is scheduled for release mid-2023. Most of the WGs are progressing on tasks to refine their assigned sections of the handbook.

In Closing

Overall attendance at the IW was 659 people, 478 remotely. This total attendance was only just short the record attendance at an IW, the 2021 IW which was fully remote. This near-record attendance is consistent with a view that INCOSE is thriving, doing a lot right and having a significant impact. Participation was truly international, from 27 countries and with 60 Chapters represented.

INCOSE Technical Director Christopher Hoffman invited all to contribute to the work of INCOSE, in his words "there being no shortage of opportunities to do so":

- Contribute to the Corporate Advisory Board (CAB) Needs
- Contribute to Future of Systems Engineering (FuSE)
- Contribute to the TechOps Initiatives
- Contribute to and review impactful products
- Contribute to and review upcoming standards (Cyber Risk, Plant System Design w/ASME, …)
- Contribute to INCOSE Systems Engineering Handbook v5
- Guide the strategic direction of systems engineering using SE Vision 2035 as a springboard;

to which can be added:

- Contribute to Chapter activities.

PPI encourages you the reader to consider contributing to your own professional growth, contributing to improvement of the engineering profession, and contributing to society by engaging with INCOSE – it is a more-than-worthwhile organization that merits our support.

Not far off is the INCOSE International Symposium in Detroit, MI, USA over June 25-30, 2022. www.incose.org/symp2022/home/when-where. PPI will be represented in force at this hybrid event – see you there!

IW2022 Working Group Highlights

by John Fitch, ESEP

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Introduction

Four members of the PPI team, Robert Halligan, Rene King, Randall Iliff and I, had the opportunity to "virtually" spread ourselves around the various working group and special interest sessions that were held at the INCOSE International Workshop 2022. It was impossible to observe and engage with every working group; over 40 groups, plus various committees and special-interest initiatives held over 130 sessions, often with six or eight sessions running concurrently.

In this article, I will limit myself to providing highlights associated with eight such working groups or initiatives. I apologize if your group, despite having a great story to tell, was overlooked. PPI SyEN is eager to share your progress and invite the broader systems engineering community to roll up their sleeves and help you accelerate your work on creating resources that will help achieve INCOSE's Vision 2035. Please contact the author at jfitch@ppi-int.com to collaborate on a brief news item (similar to those that follow) or a not-so-brief feature article that goes deep into your working group's most significant accomplishments.

Note that the working group and initiative highlights that follow are arranged in alphabetic order, not by any sense of precedence or their level of accomplishments as shared at IW2022:

- Complex Systems Working Group (CSWG)
- Digital Engineering Body of Knowledge (DEBoK)
- Empowering Women Leaders in Systems Engineerng (EWLSE)
- Heuristics Initiatives
- Human Systems Integration Working Group (HSIWG)
- Natural Systems Working Group (NSWG)
- Resilient Systems Working Group (RSWG)
- Social Systems Working Group (SocWG).

Complex Systems Working Group (CSWG)

INCOSE's Complex Systems Working Group (CSWG) seeks to enlarge the intersection between the science of complex systems and systems engineering by focusing on complexity-related knowledge that is not addressed in current systems engineering documentation such as standards, handbooks, and textbooks. Such sciences include chaos, complexity, complex adaptive systems, nonlinear static and dynamics, networks, social science, neuroscience, evolution, power laws, ecology, and others.

Given the cross-cutting nature of complexity, the CSWG collaborates with other INCOSE working groups (e.g. System of Systems, System Science and Natural Science), academia and industry in order to understand the nature of complex systems from the perspective of the various stakeholders and its applications across different industry domains. The ultimate goal of the CSWG is to move beyond the analysis of complexity to create useful products that aid in the synthesis and creation of new systems.

The CSWG has published a Complexity Primer for Systems Engineers providing practical guidance on the systems engineering of complex systems. The Primer is available through the INCOSE bookstore:

The CSWG hosted 4 sessions at IW2022 to make progress on their goals:

- CSWG Kickoff and Primer Future Revisions
- Emergence in Complex Systems
- CSWG Heuristics Focus Team Results
- CSWG Primer Future Revision Action Plan

The Heuristics session included review and refinement of a set of 18 complex system heuristics as an input to the broader INCOSE heuristics initiative.

Joint sessions were also held with the Systems of Systems (SoS) Working Group to investigate the applicability of the CSWG's complexity taxonomy to SoS complexity.

INCOSE members can learn more about the CSWG by visiting their INCOSE Connect site.

Digital Engineering Body of Knowledge (DEBoK)

The U.S. Department of Defense has launched their BETA version of the Digital Engineering Body of Knowledge (DEBoK) and seeks to engage the INCOSE community to guide its next phase of development. A well-attended DEBoK workshop at IW2022 jump-started this engagement by seeking inputs on the following topics:

- Ideas to encourage content submissions and community engagement in the DEBoK
- Courses of Action (COA) to transition the DEBoK from a currently-restricted environment for DoD, to public, in an effort to include a wider audience
- DEBoK Governance approach regarding the strategy, technology, content and roles of Government, Academia, Industry, and Non-Profit
- Sponsorship, maintenance, and sustainment plans for the DEBoK
- Methods to encourage sharing of knowledge and navigating the often sensitive considerations around IP

The DEBoK's vision was stated as:

"Provide a digital instantiation of authoritative resources for the DoD engineering community to use in implementing Digital Engineering (DE), starting with systems engineering and expanding to specific disciplines, engineering domains, and specialty areas."

Although originally created for the U.S. DoD community, the creators intend to make the DEBoK publicly accessible.

An ambitious breadth of content was defined as within the scope of the DEBoK:

- Access to best practices
- Access to a community of practitioners
- Accepted terms and definitions
- Collaboration environment
- Publicly available content
- A basis for training

To date, significant effort has been directed toward creating a planning and governance structure and a range of input templates that are intended to streamline DEBoK content creation (knowledge gathering and contribution) and consistency in knowledge formats.

The current DEBoK release is hosted on the Defense Technical Information Center (DTIC) platform.

The IW2022 workshop summarized the results of a pilot, conducted in the second half of 2021, to gather feedback from the user community on the effectiveness of the DEBoK and use that feedback to drive further development. Specifically:

- Determine if the DEBoK features meet the needs of the customer.
- Determine if the content in the DEBoK is helpful to assist practitioners with their job duties and Digital Engineering efforts
- Get feedback on layout, navigation, and style.

The pilot participants were primarily senior career staff from the U.S. government. Most participants found the initial set of content to be complete and understandable.

In addition to the user pilot, multiple focus group sessions were conducted with thought leaders from industry and academia on the topic of DEBoK governance. Governance functions, based on focus group feedback is currently being piloted.

Empowering Women Leaders in Systems Engineering (EWLSE)

The vision of INCOSE's Empowering Women Leaders in Systems Engineering (EWLSE) Group is to live in a world where women and men are equally represented as leaders in systems engineering. Our mission is to create an open systems engineering environment welcoming to all; promote the demonstrated value of women as systems engineers and leaders; engage women in engineering and systems engineering at all levels of education around the world; and enable increased participation and retention of women in systems engineering leadership.

EWLSE, founded in 2015 and with 150 members, has taken on an ambitious scope, including:

- Broadening awareness of the current state of women in leadership.
- Removing obstacles for women seeking engineering related leadership roles.
- Collaborating with professional societies, industry, government, academia, and individual advocates.
- Celebrating the benefits of diversity throughout our culture.

EWLSE measures its success against specific goals:

The systems engineering environment is open to all

- Boundaries and partitions that limit success are removed.
- Women are and know they can aspire to be leaders in systems engineering.

All systems engineers are highly valued

- Diverse leadership styles are respected and included.
- Systems engineering leadership reflects the community

Women and engineering go hand-in-hand

- At least half of graduating engineers are women.
- Female engineering graduates choose an engineering career.
- Women and men equally share technical leadership.

We collaborate as equals

- Women and men have a seat at the table.
- Cross-cultural collaboration is the norm.
- We work together across domains to build a solution for all.

Mentors and enablers are part of the culture

- Only knowledge, skills, abilities, and attitude matter.
- There is engagement at all levels of education.

- Diversity, equity, and inclusion are integral to the foundation of systems engineering

EWLSE has produced numerous events, products, services and resources to support achievement of these goals:

- Resources for women in engineering and systems engineering
- Mentor/mentee program in systems engineering
- "Not for Women Only" focused EWLSE events around the world (at workshops, symposia and conferences).
- EWLSE-related research publications.
- Nominations for annual INCOSE Technical Leadership Institute.
- Sponsor women leaders in INCOSE leadership positions.
- Support the Diversity, Equity, Inclusion Advisory team and Associate Director.

Near-term efforts in and around IW2022 are focused on:

- Establishing the EWLSE Yammer community and accelerating the pace of collaboration.
- Adding to the EWLSE Resource library four volumes of the "Rising to the Top" series featuring global women engineering leaders.
- Adding to the EWLSE Resource library the complete compilation of 24 IEEE-USA books (free to IEEE members) written by successful women engineers and technologists.
- Releasing the "*Letters to My Younger Self: How Systems Engineering Changed My Life*" ebook (volume I), comprised of 25 letters from INCOSE members around the world to their younger selves.
- Completing final refinements on 12 chapters in the Springer book "*Emerging Trends in Systems Engineering Leadership: Practical Research from Women Leaders*".

To learn more about the EWLSE, visit their public website.

Heuristics Initiatives

Heuristics was a topic of interest at IW2022. Three sessions explicitly addressed this topic from a variety of perspectives:

- Heuristics Team Open House
- CSWG Heuristics Focus Team Results
- Systems Science Working Group (SSWG) - Transdisciplinary Systems Engineering.

The Heuristics Team Open House provided an overview to interested parties of the work of the INCOSE Fellows Heuristics Team, which was initiated at IW2020. This team is currently consolidating and organizing, i.e. defining, refining and de-conflicting a list of ~600 candidate heuristics.

Working at the request of the broader INCOSE heuristics initiative, the CSWG Heuristics Focus Team conducted a results-oriented working session that considered a set complex system heuristics filtered from the INCOSE-wide candidates. Previous efforts by this team have whittled down a set of 25 candidate heuristics to 18 by using evaluation criteria that distinguish good heuristics viewed individually and as a set. Although significant progress has been made in refining the 18 heuristics for "goodness", additional work is required to ensure that they are mutually-exclusive and collectively-exhaustive (MECE) and also presented in a way that makes them memorable. Significant feedback is needed from real-world users of these heuristics to confirm their efficacy and characterize their applicability to different system engineering use cases.

The SSWG session included presentations by the "INCOSE Bridge Team". This team was set up in June, 2020 to create a conceptual bridge between two INCOSE Future of Systems Engineering (FuSE) projects that were collating SE heuristics and SE principles. The Bridge Team took a less optimistic perspective on the long-range value of heuristics by raising the concern that current SE heuristics, that

"encode" best practice based on backward-looking lessons learned, might become increasingly ineffective in the face of rising complexity and rapid change, e.g. Industry 4.0 and Society 5.0 trends. After reviewing a history of the evolution of thinking concerning systems engineering processes and heuristics, the Bridge Team proposed a higher-level principle-driven architectural framework that they believe may help the systems engineering community evolve its purpose, principles and practices to meet the increasing pace of change and complexity of systems demanded by modern civilization.

Human Systems Integration (HSI) Working Group

The purpose of INCOSE's Human Systems Integration Working Group (HSIWG) is to enhance and promote the interdisciplinary technical and management process used to ensure that the human elements of a system are appropriately addressed and integrated throughout the wider systems engineering lifecycle and management approach to a project. The HSI process consists in integrating systems engineering and human-centered design during the whole lifecycle of a human-machine system, also named socio-technical systems.

The HSIWG vision is to facilitate embedding Human Systems Integration with systems engineering, promoting the benefits of placing the proper focus on the role of people in the development, efficient delivery and operations of effective systems.

In pursuit of this vision/purpose, the HSIWG is focused on the development of products that include:

- A strong HSI chapter for the 5th edition of INCOSE SE Handbook.
- An INCOSE HSI Primer, a useful and usable document for practitioners and scientists.

The HSIWG's scope also includes:

- Addressing practices in human-centered design and engineering, certification/legal issues and product usages and maintenance (operations).
- Addressing fundamental problems such as revising the concept of system in our growing digital world.
- Contributing to the design and development of Industry 5.0.

The HSIWG conducted 3 sessions at IW2022 that collectively addressed the following topics and tasks:

- General information on HSI [2021 activity report; exchange of ideas on HSI].
- Work in progress on the HSI Primer.
- Collaborative Planning Exercise.
- HSI Event Planning: Primer Delivery, Workshop in Q4 2022 & Conference (Q4 2023).
- HSI Primer writing

To learn more about the HSIWG, visit their public website.

INCOSE members can find additional details by visiting the HSIWG INCOSE Connect site.

Natural Systems Working Group (NSWG)

The purpose of INCOSE's Natural Systems Working Group (NSWG) is to improve systems engineering processes and practices with the application of natural systems knowledge and approaches, i.e. to take full advantage of natural systems, including both biological systems and the elements and forces of nature. Its goals include:

- Create and maintain a Primer for Natural Systems and develop associated content: SE handbook content, white papers, presentations, and tutorials, and retrievable reference material.
- Establish/cultivate a Natural Systems in System Engineering Community of Practice.
- Develop and document best practices and success stories and share them with the INCOSE membership

- Recommend natural systems enhancements to standard process models.
- Grow in numbers and scope of participants and level of networking with other groups.

In pursuit of these goals, the NSWG conducted four sessions at IW2022:

- Natural systems in product development and SE
- Folding in nature and design
- Joint with Systems Science Working group
- Spatial education and SEs

Formed in 2016, the NSWG began with a broader focus on all natural systems, but over time has narrowed its focus toward bio-inspired design. The group uses the SEBoK definition of a natural system to guide its work:

An open system whose elements, boundary, and relationships exist independently of human control.

Key concepts and takeaways presented across the sessions include:

- Nature provides examples of highly efficient and optimized designs that may be leveraged to improve the design of engineered systems/products.
- Bio-inspired design can yield benefits across the product development process, but has the greatest influence when applied in the Concept stage.
- Many challenges exist to leveraging natural systems knowledge in engineering, but these can be overcome through education, changes in mindset and processes.
- Biomimicry resources exist that map natural functions to nature's solutions.
- The natural process of "folding" (buckling, wrinkling, bending, stretching, etc.) can be leveraged in design to improve performance and aesthetics and is a very active field of interdisciplinary research.
- The intersection between systems science and natural systems holds opportunities to improve the design process.
- There is a need for remedial education in spatial (3D) thinking skills among the engineers of the future, i.e. to put back the Arts into pre-university education (STEM -> STEAM).

NSWG plans for 2022 include progress on:

- Natural Systems content within the SE Handbook
- Primer on Natural Systems and SE
- A TBD work product with the Systems Science Working Group

To learn more about the NSWG, visit their public website.

Resilient Systems Working Group (RSWG)

The purpose of INCOSE's Resilient Systems Working Group (RSWG) is to further the understanding of resilience of engineered systems and to provide a clear description of the principles of resilience in INCOSE publications and outreach materials. Its goals include:

- Codify and document the state-of-the-practice for system resilience.
- Investigate, advance, and capture the state-of-the art for system resilience and related topics (such as Loss-Driven Systems Engineering).
- Collaborate with other INCOSE groups to consistently apply system resilience practice, taxonomies, tools, and techniques.
- Develop and support working group products.

In pursuit of these goals, the RSWG is focused on the development of a range of products that include:

- INCOSE Systems Engineering Handbook (SEH) sections regarding the state-of-the-practice for System Resilience.
- INCOSE Systems Engineering Body of Knowledge (SEBoK) sections regarding the state-of-the-art for System Resilience and related topics.
- INCOSE Vision sections regarding System Resilience and related topics.
- Other special publications, e.g. INCOSE Insight issues, Systems Resilience Primer.

The RSWG conducted 4 sessions at IW2022 to make progress on these products:

- The RSWG defines system resilience as the: ability of an engineered system to provide required capability when facing adversity.
- The RSWG defines an adversity as anything that might degrade the capability provided by a system.
- The RSWG uses a three-layer taxonomy for resilience including: 1) Fundamental Objectives (avoiding, withstanding, and recovering from adversity); Means Objectives, e.g. adaptability, tolerance, graceful degradation, situational awareness, etc.; 3) Architecture, Design & Operational Techniques, e.g. loose coupling, buffering, modularity, defense in depth, etc.
- Resilience should be considered early in the lifecycle processes.
- The RSWG is serving as an incubator for the field of Loss-Driven Systems Engineering (LDSE) – the unification of engineering specialty areas that address potential system losses.
- The RSWG is an extremely active group with near weekly virtual meetings, monthly invited-speaker talks and active collaborations with other INCOSE working groups.
- The RSWG is developing Vision for Resilience addendum to INCOSE's Vision 2035.
- The RSWG is supporting efforts to contribute SEBoK resilient systems content to various ISO standards.

To learn more about the RSWG, visit their public website.

Social Systems Working Group (SocWG)

INCOSE's Social Systems Working Group (SocWG) was extremely active at IW2022. The working group conducted five sessions that addressed various challenges associated with socio-technical systems:

1. Introduction to the Social Systems Working Group:

This session shared the results produced by the SocWG in 2021, highlighted collaboration opportunities with other INCOSE working groups and external organizations and shared the session plans for the remainder of IW2022.

Chartered in 2019 and with current member of over 170, the purpose of the SocWG is to:

- evaluate evolving changes to systems engineering processes and practices
- develop measures to integrate social and socio-technical systems understanding at theoretical, applied and technical levels, in collaboration through outreach initiatives with the social sciences and interested stakeholder groups

In pursuit of that purpose, the SocWG highlighted various results from 2021 including:

- Conducting a joint event and working sessions with members of the World Circular Economy Forum (WCEF).
- Contributing to the Social Systems issue of INCOSE's INSIGHT journal.
- Delivering a webinar for INCOSE's EMEA sector.
- Progress on a Social Systems Primer.

The working group considers the social dimensions of systems to be a novel space for learning and innovation in systems engineering. The SocWG is seeking to:

- Cultivate and engage diverse communities of practice to develop a shared understanding
- Learn from and share tools and resources for working across disciplines
- Develop a common language to support systems engineering activities in the context of social systems
- Promote ethical and effective practices in Social Systems Engineering (SSE)

Outreach efforts are focused on peer groups that might enable collaborative development of SSE-related content, academia to investigate the social dimensions of industry and entrepreneurship and potential partners in conducting events that address a variety of global grand challenges.

Envisioning INCOSE and the United Nations Sustainable Development Goals:

The working group conducted an educational and working session to inspire conversation among INCOSE members that might lead to INCOSE to conceptualize projects around the achievement of the 17 U.N. Sustainable Development Goals (SDG's). The SocWG hopes to serve as a hub in the framing and development of such projects.

After a historical background for the U.N. SDG's was provided, a system dynamics model of the SDG's was presented as a potential tool to better understand the interaction among the 17 SDG's. Recent historical global (country-by-country) data was used to calibrate the model and project the calibrated model into the future with the goal to optimize the model to identify paths to a better future.

INCOSE Social Systems Engineering, AI & Ethics Workshop:

The working group provided an overview of ethics in the context of AI and conducted a workshop on how to apply ethical concepts and identify ethical concerns at each stage in the lifecycle (Concept, Design, Development, Use and End-of-Life) of an AI-enabled system.

The lifecycle exercise considered questions concerning:

- Problem Framing: How is the problem framed? What social stakeholders could be affected by this problem framing?
- Data Collection: Are there sampling problems/bias in the available data? How can these biases be overcome? What is the impact of this bias during use and End-of-Life if not overcome?
- Data Preparation: How would attribute selection shape the ethical lifecycle of the product?
- Design Decisions: How will decisions be made during AI product development?
- Ethical Proximity: How might the AI product be used other than its intended purpose?

Enterprise Transformation in the 21st Century:

The working group led a lengthy session to explore 21st century enterprise transformation practices and to identify the potential for joint projects to accelerate such transformation. In this context, "enterprise" reaches beyond its more common usage as a business to larger systems such as cities, nations or global entities. Two case studies were shared to provide differing perspectives on transformation:

- Modeling Workforce and Culture at the Enterprise Level: Using systems thinking and social science to define large scale enterprise transformation (U.S. DoD Digital Transformation)
- Upgrade UK National Accounts: Explore a successful people-intensive Enterprise transformation from ISO 15288:2015, ISO 42010:2011 and Living Systems perspectives.

The session concluded with a roundtable discussion on the intersection between socio-technical networks and digital transformation.

Systems Engineering Transformation Narratives:

This working session included four brief "lightning round" presentations that addressed diverse enterprise transformation situations:

- Realities Possibilities for the 21st Century Enterprise – Transforming the Role of Business in Society
- Transition of Mixed System of Systems
- Smart Cities Initiative
- Policy Content Modeling

These topics were used to stimulate discussion on the challenges of expanding the scope of INCOSE's practices to address the complexities and required capabilities associated with managing the evolution of such diverse multi-domain socio-technical systems.

Social Systems WG Planning:

This session included brief reports on the outcomes from previous sessions and the impact these session might have on working group plans for 2022.

INCOSE members can learn more about the Social Systems Working Group by visiting their INCOSE Connect site.

What's Happening with SysML v2?

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Authored for PPI SyEN.

A very welcome update on the status of SysML v2 was given at the INCOSE International Workshop (IW) on January 30th, 2022 by the SysML v2 Submission Team (SST). This report is based on a presentation at the IW delivered by SST Co-Lead Sanford Friedenthal. [1]

SysML v2 is intended to support Model-Based Systems Engineering (MBSE), which is defined by PPI as "the formalized application of modeling to support system requirements, design, analysis, verification and validation activities, beginning with problem definition and continuing throughout the development and later lifecycle stages." The INCOSE definition of MBSE is very similar: "the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."

One of the objectives of SysML v2 is support to digital transformation, not only with models and simulations, but also with their integration with other engineering data on a lifecycle basis – the digital thread. The digital thread is a data-driven architecture that links information generated from across the product lifecycle. The digital thread is envisioned to become the primary or authoritative data storage and communication vehicle for an organization's products at any instance of time.

SysML was first conceived in 2001 and was released in 2006 as SysML v1.0. The language is currently at v1.6, with work in progress on v1.7. Although SysML v1 has gained a following among engineers, the language has also disappointed many with its software, not general systems orientation, issues with executability and the inability to exchange models between tools of different tool vendors. These last two points were major drivers to the SysML v2 project, reflected in requirements for the language, but not accomplished in SysML v1. The steep learning curve associated with SysML v1 has also held back its widespread adoption, we believe.

Opportunity to improve SysML v1 led to the Object Management Group, the home of SysML, releasing in December 2017 a RFP for SysML v2 and the establishment of the SysML v2 Submission Team (SST) to develop SysML v2, with the objectives of enhancing:

- Precision and expressiveness of the language
- Consistency and integration between language concepts
- Interoperability with other engineering models and tools
- Usability by model developers and consumers
- Extensibility to support domain specific applications,

and with a migration path for SysML v1 users and implementors.

Key elements of SysML v2 are:

- A new metamodel, grounded in formal (rigorous) semantics, and not constrained by UML but preserving the UML modeling capabilities applicable from a systems perspective

- Robust graphical, tabular and textual visualizations based on flexible view & viewpoint specification and execution
- Standardized Application Program Interface (API) to access the model.

The metamodel specifies the core concepts of the language using formal semantics. A systems model library instantiates for use the core concepts from the metamodel. The user creates the user model from content of the systems model library. The separate API enables access to the user model in a standard way.

The expressiveness of the SysML v2 language is overviewed in Figure 1. [1]

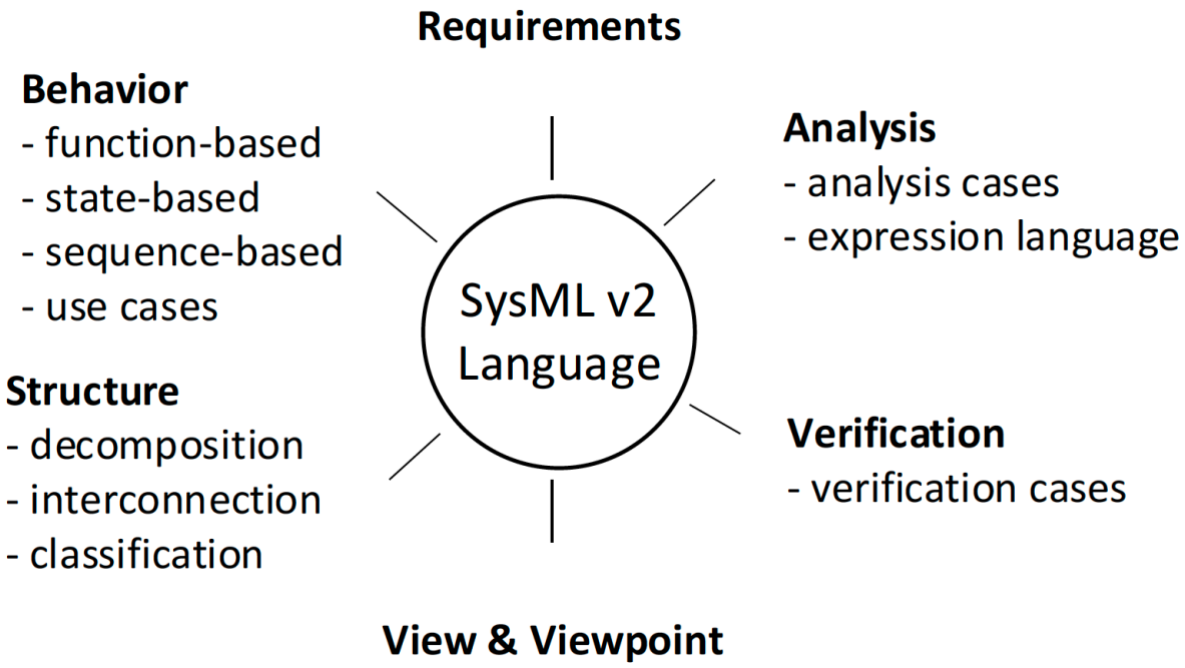


Figure 1: Overview of SysML v2 Expressiveness

The SysML v2 *Part* and its Definition replace the SysML v1 part property and *Block*. SysML v2 parts are characterised by information that includes:

- name:
- attributes:
- ports (interfaces):
- performs actions:
- exhibits states:

The logic and soundness of this characterization is self-evident.

SysML v2, as mentioned above, has a textual syntax that unambiguously corresponds to the graphical syntax. This bimodal capability offers many advantages for communication, including additional options for model interchange between organizations and between tools.

State-based modelling capability is similar to that provided by Harel statecharts [2], with each state defined in terms of:

- condition for exiting one state and entering another state (transition)
- action (response) upon entry to the state
- action to be performed in the state
- action upon exit from the state
- constraints that apply while in the state.

The logic and usability of SysML v2 is improved considerably by consistent use of definitions and usage, by way of Definition and Usage elements. A Definition element defines an element such as a part, action, requirement, attribute, state, constraint, connection or view. A Usage element is a usage of a Definition element in a particular context. This pattern is applied consistently throughout the language.

SysML v2 accommodates Product Line Engineering (PLE) and other aspects of engineering practice involving variants. All Definition and Usage elements can be defined as variation points. A variant represents a particular selection at a variation point. A selection at one variation point can constrain selections at other variation points. A particular system can be configured by making choices at each variation point consistent with the specified constraints. This capability of SysML v2 is extremely valuable and brings the language into the 21st century, in our view.

A partial mapping of SysML v2 terminology to SysML v1 is shown in Figure 2, [1] followed by a comparison of SysML v2 with SysML v1.6.

SysML v2	SysML v1
part / part def	part property / block
attribute / attribute def	value property / value type
port / port def	proxy port / interface block
action / action def	action / activity
state / state def	state / state machine
constraint / constraint def	constraint property / constraint block
requirement / requirement def	requirement
connection / connection def	connector / association block
view / view def	view

Figure 2: SysML v2 to SysML v1 Terminology Mapping

SysML v2 is simpler to learn and use:

- Systems engineering concepts are designed into the language metamodel versus added-on
- Consistent application of definition pattern and usage pattern applies
- Terminology is more rational and consistent throughout the metamodel
- Ability to decompose parts, actions, … applies

SysML v2 is more precise:

- Precise textual syntax and expression language
- The language has a formal semantic grounding
- Requirements as constraints

SysML v2 is more expressive:

- Modeling of variants
- Analysis cases
- Trade-off analysis
- Individuals, snapshots, time slices
- More robust quantitative properties (e.g., vectors, …)
- Query/filter expressions
- Replication, missing in SysML v1, included in SysML v2 Activity Diagram

- Executable
- More extensive metadata overall

SysML v2 is more extensible

- Simpler language extension capability, based on model libraries

SysML is more interoperable

- Standardized API with conformance tests
- OSLC
- Graphical, textual and tabular representations
- Cross-project element referencing.

In short, PPI predicts that SysML v2 will be a game changer, everything that SysML v1 was intended to be, and much, much more.

The final submission of SysML v2 by the SST to the OMG is expected to take place in the July to September, 2022 timeframe, with finalization of the OMG-approved SysML v2 Specification anticipated a year later. Implementation of SysML v2 tools by the tool vendors is expected to take place through 2022 and 2023, with commercial tool releases progressively through 2023.

SysML v2 resources understood to be available include a monthly release repository that contains:

- Release content
- Specification documents (for KerML, SysML and API)
- Training material for SysML textual notation
- Training material for SysML graphical notation
- Example models (in textual notation)
- Pilot implementation
- Web access to prototype repository via SysML v2 API
- Web access to Tom Sawyer visualization tooling.

Additional resources include:

- Open-source repository:
- Google group for comments and questions: (to request membership, provide name, affiliation and interest).

References:

[1] Friedenthal, Sanford, "*SysML v2 Submission Team (SST) SysML v2 Update*", 2022 Annual INCOSE International Workshop, presentation

[2] Harel, David, "*Statecharts: a visual formalism for complex systems*", Elsevier, Science of Computer Programming, Volume 8, Issue 3, June 1987, Pages 231-274

SYSTEMS ENGINEERING RESOURCES

Useful artifacts to improve your SE effectiveness

Organization: Institute for Asset Management

The Institute of Asset Management (the IAM) is an international professional body for asset management professionals. The IAM develops asset management knowledge and best practice and generates awareness of the benefits of the asset management discipline for the individual, organizations and wider society. The IAM exists to advance the discipline of asset management, not only for people and organizations involved in the full lifecycle acquisition, operation and care of physical assets but also for the benefit of the general public. Established in 1994, the IAM is a not-for-profit organization with over 2000 individual and 300 corporate members.

The IAM provides a diverse set of knowledge resources, many of which address the principles and practices associated with effective lifecycle management of assets in order to maximize the achievement of an organization's objectives and the value delivered to its stakeholders. In accordance with the ISO 55000 standards, the IAM defines asset management to include more than physical assets such as infrastructure (facilities, equipment, etc.), rather anything that has potential or actual value to an organization.

The IAM's Asset Management – an Anatomy document provides an overview of IAM's framework/model which decomposes the asset management discipline into 39 subjects (aka capabilities) that extend and supplement the ISO 55000 standards.

The IAM's Competences Framework provides a comprehensive description of what asset management professionals should be able to do, know and understand.

The IAM's Subject Specific Guidelines (SSG's) expand the asset management principles and practices, addressing the 39 subjects in the IAM's framework in 6 groups (landscapes):

- Strategy and Planning
- Asset Management Decision Making
- Lifecycle delivery
- Asset Information
- Organization and People
- Risk and Review

Experienced systems engineering practitioners will find it easy to map these guidelines to a variety of familiar disciplines, e.g. decision-making, configuration management, reliability engineering, risk assessment/management, contingency planning & resilience analysis and decommissioning/disposal. A separate systems engineering guideline is in development.

The IAM's Knowledge Library offers a mix of asset management resources, some available to members-only, others free to view or download or available to purchase by non-members.

The IAM offers both individual and corporate memberships. Join here.

Organization: Resilience Engineering Association

Resilience Engineering is a trans-disciplinary perspective that focuses on developing on theories and practices that enable the continuity of operations and societal activities to deliver essential services in the face of ever growing dynamics and uncertainty. As a distinct field, Resilience Engineering (RE) emerged from the safety science community. It addresses complexity, non-linearity, inter-dependencies, emergence, formal and informal social structures, threats and opportunities.

The Resilience Engineering Association (REA), a non-profit governed by French Law, brings together some 600 members and non-members, from academia and industry, across the globe to collaborate to advance the field.

The REA website provides a variety of introductory readings and presentations on the Resilience Engineering concepts on its Where do I start? page, beginning with definition(s) of resilience.

The REA hosts a biennial symposium. Access abstracts and proceedings from recent symposia here.

The REA conducts an on-going Young Talents Program that provides Master and PhD students in the field of RE with the opportunity to present their work and receive mentorship from prominent researchers. Student researchers who are accepted into the program are provided with travel cost reimbursement to attend a one-day workshop held in conjunction with each symposium.

Additional Resilience Engineering resources include contributions from thought leaders in a variety of media:

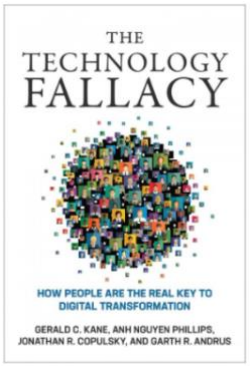
- Podcasts
- Videos
- Publications
- REA Blog
- REA Newsletter

Join the REA.

Book Review: The Technology Fallacy – How people are the real key to digital transformation

By Scott Phillips, Founder, i4score.com

Editor's Note: In his outstanding feature article, Capability Architecture for Industry 4.0 – Digital Transformation of the Manufacturing Enterprise, published in SyEN Edition 108 (January, 2022), Scott Phillips referenced a book, *The Technology Fallacy – How people are the real key to digital transformation*, as a source of several key Digital Transformation principles. The SyEN team requested that Scott share more about these principles in the form of a book review. Thanks to Scott for sharing his personal insights.



The main premise of The Technology Fallacy is that digital transformation is about the organizational changes required to harness the power of technology. The authors (Gerald C. Kane, Anh Nguyen Phillips, Jonathan R. Copulsky and Garth R. Andrus) argue that digital disruption is primarily about people and that effective digital transformation involves changes to organizational dynamics and how work gets done. A focus only on selecting the right technologies is not likely to succeed.

The authors draw on four years of research, conducted in partnership with MIT Sloan Management Review and Deloitte, surveying more than 16,000 people and conducting interviews with managers at

companies such as Walmart, Google and Salesforce. Their conclusion is that every organization needs to understand its "digital DNA" in order to stop "doing digital" and start "being digital".

Competency Traps

The authors make the point that "what got you here, won't get you there". Their research reflects that established companies typically face significant challenges from digital transformation, primarily their past success. The example they provide is GE. Six Sigma was a key factor associated with GE's success during the 1990s and early 2000's. However, it is almost impossible to maintain Six Sigma standards while also experimenting with new ways of doing business. The process is not conducive to the types of agile responses to environmental shifts that characterize the world of digital business.

Adoption Gaps

In chapter 2 of the book, the authors highlight their perspective that the key challenge that companies face with respect to digital business is the widening gap in the rates at which individuals, business and public policy respond to technology. They use the seminal work of Everett Rogers on the innovation adoption curve to demonstrate that the speed of individual adoption, business adaption and public policy assimilation is widening over time. The result is that the adoption gap between early adopters, early majority, late majority, and laggards is more significant over time and that organizations can fall behind competition more quickly than before.

Their research shows that individual adoption is not the most critical digital disruption problem that most managers face. Individuals generally still adopt new technology faster than organizations can adapt to it. They also point out how this has changed over the last ten to fifteen years. Prior to the first decade of this century, businesses adapted more quickly to technology than individuals did based purely on simple economics. Most people could only afford technology through their employers, and the so-called enterprise-grade technology was far more advanced than consumer-facing technology. As the costs of information technology dropped, powerful consumer-facing online platforms became widely available, and powerful mobile devices have become ubiquitous.

The authors end this chapter exploring the question of whether and how an organization can increase its absorptive capacity, with the goal of narrowing the adaption gap. They reference research from two bodies of work that suggest some specific steps that companies can take:

- Expand talent diversity by attracting the right kind of individuals.
- Augment the prior knowledge base by helping employees develop digital skills.
- Enhance the organization's mechanisms for effectively acquiring knowledge.
- Increase the velocity of internal information flows through organizational initiatives.
- Focus on helping employees understand the "why" to close the "knowing-doing" gap.

Digital Leadership

In chapter 6 the authors turn their attention to the topic of digital leadership. Their research finds that effective leadership is one of the most critical factors associated with digital maturity. The most important takeaway for me in this discussion is the distinction that the authors make between the characteristics of leadership that are unchanging over time versus those that are more closely tied to the particular demands of digital disruption. The question is which are which? Which principles of effective leadership transcend digital disruption, and which principles require adaptation? When is it appropriate to stick with what has worked, and when is it appropriate to update one's leadership playbook? The authors share a list of core leadership capabilities that are particularly important today:

- Direction: Providing vision and purpose.
- Business judgment: Making decisions in an uncertain context.

- Execution: Empowering people to think differently.
- Inspirational Leadership: Getting people to follow you.
- Innovation: Creating the conditions for people to experiment.
- Talent building: Supporting continuous self-development.
- Influence: Persuading and influencing stakeholders.
- Collaboration: Getting people to collaborate across boundaries.

Cultivating a Digital Environment

In chapter 11, the authors discuss culture. They start with the admonition attributed to management guru Peter Drucker: "Culture eats strategy for lunch". They argue that culture is important in almost every discussion of digital transformation. Their research showed that an inflexible culture, complacency, and lack of agility are cited as the biggest threats companies face because of digital trends. The authors spend the balance of this chapter focusing on three important points they learned about digital culture:

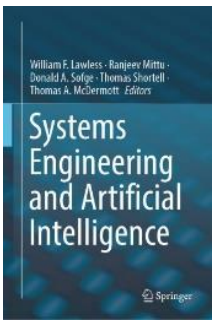
- Digital culture is critical to driving digital business adoption.
- Digital culture is distinct and consistent, associated with digital maturity.
- Digital culture is intentional.

Organizing for Agility

The authors trace the origins of "agile" back to 2001 when a group of software developers gathered to define the values and principles associated with agile software development. Agile describes an approach to software development that substitutes rapid, iterative sprints for the more traditional "waterfall" approach, which moves sequentially through several distinct phases including requirements, analysis, design, coding, testing and operations. In the authors' research, respondents reported that their organizations are too slow to change, too complacent, and don't have a sufficiently flexible culture to adapt quickly enough to changes in the competitive environment wrought by technology.

The authors quote former Secretary of State Condoleezza Rice that the timeframe and inevitability of change are much easier to understand retrospectively than prospectively. They find that responding too quickly and aggressively to changes may leave companies adapting to the emerging technologies prematurely and potentially squandering time and resources that might be best utilized responding to more imminent threats. On the other hand, failing to understand the urgency of a threat can leave companies in the dust and unable to recover. The authors use the example of additive manufacturing, which has yet to be felt by many industries but has completely disrupted the hearing aid industry.

Collaborating beyond the Enterprise

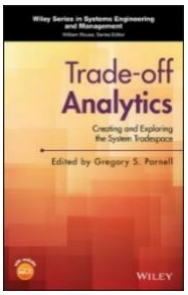


Many digitally maturing companies are also thinking about collaboration beyond the boundaries of the organization – such as with customers, partners, and even competitors. Digitally maturing companies are more likely to encourage collaboration along each of these boundaries. The authors emphasize that collaboration today arises from the democratization of information, available both inside and outside the organization. The technological infrastructure is now in place to support this type of collaboration, and managers might begin thinking about whether new ways to collaborate would allow them to do work differently.

Conclusion

I highly recommend this book to anyone involved in an organizational digital transformation whether they are leading it or participating in some way. In my case, I consult with small-medium sized manufacturers regarding their adoption of new technology. I found that the authors' insights did a great job of summarizing and describing the organizational challenges that I see every day.

Book: Trade-off Analytics



Trade-off Analytics: Creating and Exploring the System Tradespace presents a decision management process based on decision theory and cost analysis best practices aligned with the ISO/IEC 15288, the Systems Engineering Handbook, and the Systems Engineering Body of Knowledge. Edited by Dr. Gregory Parnell of the University of Arkansas, lead author of the *Handbook of Decision Analysis* (Wiley 2013), this 640 page book provides a framework for trade-off analysis to generate the tradespace and evaluate value and risk to support system decision-making throughout the life cycle.

Key concepts include:

- Techniques to identify and structure stakeholder objectives and creative, doable alternatives
- Advantages and disadvantages of tradespace creation and exploration techniques
- Sources of uncertainty in the system life cycle
- Techniques to identify, assess, and model uncertainty using probability
- How to perform a trade-off analysis using the INCOSE Decision Management Process

The book is written for upper undergraduate students and graduate students studying systems design, systems engineering, industrial engineering and engineering management. This book also serves as a resource for practicing systems designers, systems engineers, project managers, and engineering managers.

Published by Wiley in 2016. ISBN: 978-1-119-23753-2. Details here.

Recent Systems Engineering - Artificial Intelligence Publications

Two recent publications from Springer address the implications of Artificial Intelligence (AI) on the engineering of systems.

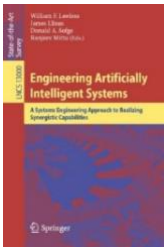
Systems Engineering and Artificial Intelligence (2021) provides a broad overview of the benefits from a systems engineering design philosophy in architecting complex systems composed of artificial intelligence (AI), machine learning (ML) and humans situated in chaotic environments. Editors include William F. Lawless, Ranjeev Mittu, Donald A. Sofge, Thomas Shortell and Thomas A. McDermott.

Topics include:

- AI and the future of systems engineering
- Emergence
- Human systems integration to develop robust and effective human-machine teams
- Verification and validation of systems using AI/ML
- Human–machine understanding - utility of causal models and counterfactuals
- Open questions concerning the science of autonomy

ISBN: 978-3-030-77283-3. Available through SpringerLink.

SYSTEMS ENGINEERING RESOURCES



Engineering Artificially Intelligent Systems - A Systems Engineering Approach to Realizing Synergistic Capabilities addresses the effective and efficient designs of computational systems and how a systems engineering perspective may provide a framework for identifying the interrelationships and patterns of change (cascading interdependencies) between components. Editors include William F. Lawless, James Llinas, Donald A. Sofge and Ranjeev Mittu.

Derived in part from presentations given at the Association for Advancement of Artificial Intelligence (AAAI) 2021 Spring Symposium, the book covers topics such as:

- AI, machine learning, and reasoning
- Data and information fusion
- Intelligent systems
- Autonomous systems
- Interdependence and teamwork
- Human-computer interaction
- Trust
- Resilience

ISBN: 978-3-030-89385-9. Available through SpringLink.

Introduction to Modelica

Modelica is one of the leading technologies used for System Simulation and provides many benefits in the design, optimization, and operation of products and processes. Erik Åberg of Eradity has published a five-lesson series that introduces Modelica to new users.

- Introduction to Modelica
- Writing Equations in Modelica
- Connectors and Types
- Using Functions
- Wastewater Overflow Example (Using the Fluid Library)

Erik will be sharing a feature article on System Simulation in the next edition of SyEN. Get a head start on one technology for performing these simulations by reading his Modelica posts.

Methods for Integrating Dynamic Requirements

The Systems Engineering Research Center (SERC) has released a final technical report, SERC-2022-TR-001, titled "Methods for Integrating Dynamic Requirements". A team led by Dr. William B. Rouse of Georgetown University conducted a year of research into the design of solutions that demands both the flexibility and agility to address the dual challenge of uncertainty in needs and technologies.

The report offers a decision framework that enables flexibility and agility, and provides guidance on when to pursue optimal, highly integrated solutions, and when to hedge investments.

The 58 page report addresses topics such as:

- Sources of uncertainties: Evolving market needs/trends, mission requirements, regulatory environment, politics, etc.

- Managing uncertainties: Based on the level of requirements and technology uncertainty, should we optimize, adapt or hedge?
- Methodologies for representing solutions: Human-Centered Design, Set-Based Design, Quality Function Deployment, Design Structure Matrices, etc.
- Projecting value: Multi-stakeholder, multi-attribute techniques for estimating utility/value while accounting for uncertainty
- Use cases for the decision framework

The report presents three case studies to illustrate the application of the proposed decision framework:

- Driverless cars for disabled and older adults
- Energy policy for global warming
- Policy portfolio to enhance STEM talent pipeline

The report also includes an overview of the requirements and initial concept for an Uncertainty Management Advisor software tool based on the decision framework.

For additional details see SERC announcement. Download the report here.

> *There are two main reasons for iteration from design back to requirements. One is that "the problem" has changed. The other is that the problem was never properly defined in the first place (when it could have been). The latter is much more common.*
>
> **Robert Halligan**

FINAL THOUGHTS

Dear Reader,

As this month's edition is about cultivating progress to achieving the vision of SE, whether that vision is INCOSE's 2035 vision, the SE capability level that your organization is working towards, or the professional goals that you have set for yourself, we would like to emphasize the importance of planning in order to achieve your vision.

Quote about planning. Growth will not take place haphazardly, and even it does, it won't happen to the extent that is possible without setting key objectives/goals, performance measures, and frequent feedback based on those objectives.

For the individuals out there looking at catapulting their SE skills in preparing for these shifts, PPI would like to propose the following tips to apply along the journey of bolstering your career.

1. Reading systems engineering-related material and staying up-to-date with progress on standards, guides, frameworks, modeling languages, etc (including newsjournals such as this one and other formal publications and articles on LinkedIn, etc)
2. Getting involved with engineering societies that align with your values and your areas of interest (many are mentioned in this edition of PPI SyEN. Find pages of sites of interest on LinkedIn or Yammer etc)
3. Participating in high-quality systems engineering training (see PPI's website for a list of courses that may be of interest to you).
4. Acquiring your SE certification (visit CTI's website to find out about our SE certification program)
5. Applying a competency framework to guide your path to develop the skills and areas that you would like to improve in (for example INCOSE's competency framework)

If you'd like PPI's guidance on shaping the SE capability of your team, organization of all your career personally, feel free to send us an email at enquiries@ppi-int.com and we would be glad to assist you by arranging a friendly phone call with no obligation for commitment to our services whatsoever.

> "
>
> *Planning is bringing the future into the present so that you can do something about it now*
>
> **Alan Lakein**