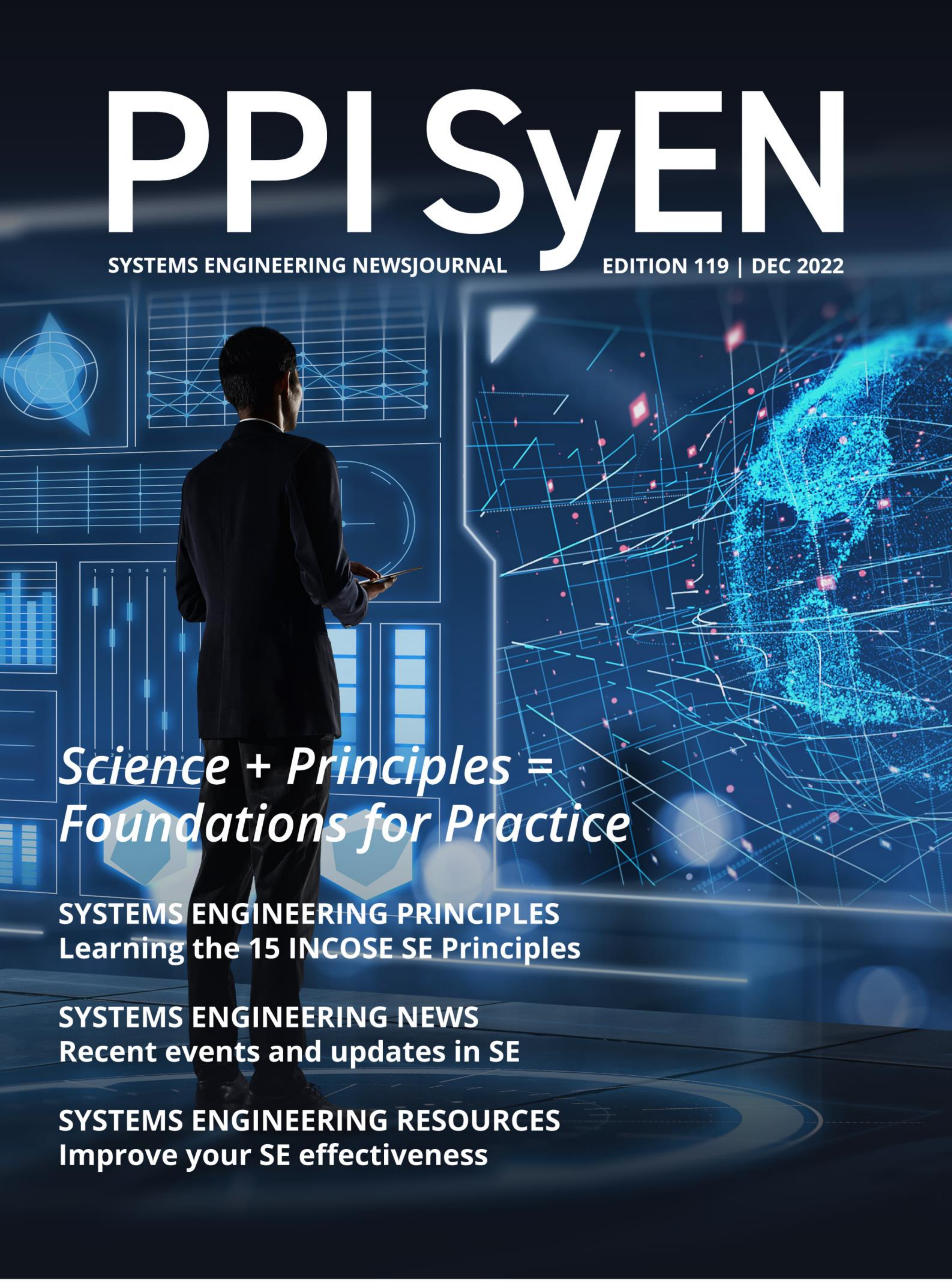


PPI SyEN

SYSTEMS ENGINEERING NEWSJOURNAL

EDITION 119 | DEC 2022

Science + Principles = Foundations for Practice

SYSTEMS ENGINEERING PRINCIPLES
Learning the 15 INCOSE SE Principles

SYSTEMS ENGINEERING NEWS
Recent events and updates in SE

SYSTEMS ENGINEERING RESOURCES
Improve your SE effectiveness

PPI SyEN

EMAIL: PPISyEN@PPI-Int.com

PUBLISHER

Project Performance International
2 Parkgate Drive
Ringwood, Vic 3134 Australia
Tel: +61 3 9876 7345

Tel Brazil: +55 12 9 9780 3490
Tel UK: +44 20 3608 6754
Tel USA: +1 888 772 5174
Tel China: +86 188 5117 2867

www.ppi-int.com

PPI SyEN (PPI Systems Engineering Newsjournal) is published monthly.

Archived editions and subscriptions to future editions are available for free at: https://www.ppi-int.com/syen-newsjournal/

WELCOME

Welcome to the final PPI SyEN edition of 2022!

In South Africa, December is 'Dezember' colloquially and with this month comes a very particular energy in the air, it's festive season – time to put your pens down and your hands up and celebrate another year. I know a similar spirit is carried in many other parts of the world.

I enjoy December for the much the same reasons. I also use this time to reflect on my personal and professional progress and I'm sure it's much the same for the PPI SyEN readership. This month's edition of PPI SyEN carries the theme: 'Science + Principles = Foundations for Practice' – I love it!

There are so many ways to contribute to this world through systems-related phenomena. Recently I've been reflecting on the balance of creation versus consumption. We live in a highly consumptive world – resources, technology, food, movies, there is so much to enjoy. However, there is a special feeling that comes from creating something of one's own, assimilating ideas and producing a new perspective to put out there into the universe, something that will serve as a legacy beyond one's years on this planet.

One of my goals in 2023 is to create more content, to write more articles and to deliver more presentations. I have ideas about systems thinking, systems engineering; how we can simplify and apply the powerful principles that underpin the work that we do and it is time to put them out there. I encourage each of you to do the same. I hope that this edition provides much inspiration for doing so as it is packed with quality content to get your creative juices flowing.

It is such an exciting time as there are several standards being developed to equip systems engineering (and its cousin, business analysis). There are numerous awards and webinars tantalizing and encouraging us to push boundaries in thinking, to incorporate concepts into our practical work and to level up our development in this digital age. Not to be missed is the Feature Article on 'Reflections on INCOSE Systems Engineering Principles' by John Fitch. He provides much food for thought with this superb article. I have to thank John for his tremendous contribution to PPI SyEN this year. He has done an outstanding job.

From PPI to you, we wish you wonderful festive season and a prosperous new year. I'm really looking forward to what the future holds!

Bring on 2023 ☺

René

Managing Editor, PPI SyEN

SYSTEMS ENGINEERING NEWS 4

Recent events and updates in the field of systems engineering

CONFERENCES, MEETINGS & WEBINARS 11

Events of relevance to systems engineering

FEATURE ARTICLE 20

Reflections on INCOSE Systems Engineering Principles 20

By John Fitch

SYSTEMS ENGINEERING RESOURCES 36

Useful artifacts to improve your SE effectiveness

FINAL THOUGHTS FROM SYENNA 40

PPI Systems Engineering Newsjournal (PPI SyEN) seeks:	**PPI defines systems engineering as:**
➢ 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	*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

PDMA Corporate Innovation and Student Awards

On 14 November, the Product Development & Management Association (PDMA) celebrated multiple awards during its 2022 Inspire Innovation Conference in Orlando, Florida, USA.

The Hershey Company, a well-known leader in the snacks industry, received the 2022 PDMA's Outstanding Corporate Innovator (OCI) award winner. The OCI Award, in its 35th year, is a global innovation award which recognizes sustained and quantifiable business results from new products and services. This year's award highlights The Hershey Company's record of seamless and open innovation resulting in growth, strong work processes, brand recognition and an exemplary culture. In support of this assessment, the Wall Street Journal lauded The Hershey Company for their creative diversification strategies in a difficult market environment.

Learn more about the OCI award here. Read the PDMA press release.

The Inspire Innovation Conference also provided the culmination of the PDMA 2022 Global Student Innovation Challenge. This year's competition included 20 teams representing 13 universities and 6 countries. Each team submitted their idea for a novel product, service, or software application, detailing their unique value proposition, evidence of demand, and mock-up or embodiment of that product. The top three teams were invited to present their idea at the Inspire Innovation Conference. Award were as follows:

First place team:
Team NanoAid from University of Calgary (Canada)
Members: Amy Houston, Amneet Deol, Amina Khan, Giovanna Acosta, Hunter Marcelo

View the presentation: NanoAid – Harnessing the Power of Nature To Fight Chronic Wound Infections.

Second place team:
Team Solar Mineralis from University of Tulsa, (USA)
Members: Bryce Goswick, Andrew Varvara, Suraj Vodnala

View the presentation: Solar Mineralis – Research, Develop, and Market Novel Solar Cell Solutions

Third place team:
Team Counting Assistant from Duke University (USA)
Members: Winnie Cross, Sydney Collins, Elena Rippeon

View the presentation: Counting Assistant

See the submission announcement for the 2023 Global Student Innovation Challenge. Submission deadline is 1 June 2023.

Modelica Association News

The Modelica Association is a non-profit organization with members from Europe, U.S.A., Canada and Asia. Since 1996, it develops coordinated, open access standards and open source software in the area of cyber physical systems.

Current Modelica Association standards include:

- Modelica Language
- Functional Mock-up Interface (FMI)
- System Structure and Parameterization (SSP)
- Distributed Co-Simulation Protocol (DCP)
- Functional Mock-up Interface for embedded Systems (eFMI)

The Association publishes a quarterly newsletter. Here are some the highlights from the latest release.

American Modelica Conference 2022

The American Modelica Conference 2022 was held in Richardson, Texas, USA from 26-28 October with just over 100 in-person and virtual attendees. Keynote speakers were Dr. Dirk Zimmer of the DLR German Aerospace Center's Institute of System Dynamics and Control and Dr. Scott Bortof of Mitsubishi Electric Research Laboratories (MERL).

Six tutorials were delivered to in-person participants:

- Introduction to Modelica with Modelon Impact
- The DLR Thermofluid Stream Library. From simple components to the prototypic control of a complex thermal architecture
- Introducing the Digital Engineering Commons: the first DevOps Platform for Collaborative Digital Engineering
- Introduction to Modelica and Thermo-fluid Modeling with Applications from the Buildings Library
- Acausal modeling in Julia with ModelingToolkit.jl
- Introduction to Modeling, Simulation, Debugging, and Interoperability with Modelica and OpenModelica

View details on these tutorials and links to associated resources here.

Paper awards, based on a peer review process, included:

- Best Paper: "BESMOD – A Modelica Library for Providing Building Energy System Modules". (Fabian Wüllhorst, Laura Maier, David Jansen, Larissa Kühn, Dominik Hering, and Dirk Müller)
- First Runner Up: "Transient Simulation of an Air-source Heat Pump under Cycling of Frosting and Reverse-cycle Defrosting". (Jiacheng Ma, Donghun Kim and James E. Braun)
- Second Runner Up: "Performance Enhancements for Zero-Flow Simulation of Vapor Compression Cycles". (Hongtao Qiao and Christopher Laughman)

Download the American Conference proceedings (168 pages). This document includes 17 papers spanning topics such as Building Energy, Aerospace, Power Generation, Language/Tools and Model-Based Design.

SYSTEMS ENGINEERING NEWS

Modelica Vendor News

Modelica vendors highlighted numerous new capabilities:

- Dassault Systemes announced that Dynamic Modeling Library (Dymola) 2023x will be released in November 2022 with enhancements in model editing, simulation, and model import/export (using FMI 3.0 file format).
- Siemens Digital Industries Software reports that Simcenter Webapp Server release 2022.1 enables creation and sharing of engineering web applications leveraging the FMI 2.0 standard.
- Siemens Digital Industries Software also announced the release of Simcenter Amesim, a full-featured editor for the Modelica language that enables using and maintaining Modelica legacy code and building custom Modelica-based models, creating bridges between the acausal world of Modelica and the causal environment of Simcenter Amesim.
- Wolfram announces the imminent release of Wolfram System Modeler 13.2 with enhancements such as interactive exploration of simulation results, precise model validation, quantification of system performance, and free libraries for aircraft and rotating machinery.
- Modelon has released Modelon Impact 2022.2 and Modelon Impact Cloud along with new cases studies based on work with Lightyear (All-Electric Solar Driving), Siemens Energy (Heat Pump Performance Improvement), and Saab (Modernizing Fighter Aircraft).

View details of these and other announcements in the latest Modelica Association newsletter. Subscribe to the newsletter and other Modelica messages here.

Learn more about the Modelica Association.

NAFEMS ASSESS Initiative

NAFEMS, the International Association for the Engineering Modelling, Analysis and Simulation community, has announced that the Analysis, Simulation & Systems Engineering Software Strategies (ASSESS) Initiative has, effective June 2022, moved under the NAFEMS organizational umbrella.

Established in 2014, ASSESS is a broad reaching multi-industry initiative, with the primary goal of facilitating a revolution of enablement that will vastly increase the availability and utility of Engineering Simulation, leading to significantly increased business benefits across the full spectrum of industries, applications, and users. In broad terms, ASSESS aims to bring some thought leadership to the engineering simulation industry by bringing together key players to discuss long-term direction.

The combined organization is intended to enhance the ASSESS activities with the infrastructure, experience, knowledge, reputation, and network that NAFEMS has built over the past nearly 40 years. NAFEMS will benefit from the longer-term view of technology that ASSESS provides.

ASSESS will remain a self-contained initiative, under NAFEMS, a thought leadership group with a select membership. ASSESS will have the autonomy to develop its own strategies, make independent recommendations, and decide on the priority of initiatives. Similarly, NAFEMS will be under no obligation to adopt or implement ASSESS recommendations.

The mission of NAMEMS is to:

"Provide knowledge, international collaboration and educational opportunities for the use and validation of engineering simulation."

The complementary and updated vision for ASSESS is:

> *"To lead every aspect of engineering simulation toward a more valuable and accessible future in the medium to long-term, leveraging the expertise and knowledge of top-level figures in industry, government, and academia."*

Read the NAFEMS announcement. Learn more about ASSESS here.

Important progress towards realizing the ASSESS vision is planned for the ASSESS Congress 2023 be held in Atlanta, Georgia, USA on 26-28 March 2023. Learn more and register here.

Business Analysis Standard Published

The International Institute of Business Analysis (IIBA) has announced the release of the Business Analysis Standard. The Standard is a new publication that provides a simplified, inclusive view of business analysis and includes the foundational concepts in an easy-to-use format. It delivers a comprehensive view of the foundation for effective business analysis and provides the direction for the future development and integration of business analysis standards and resources.

IIBA's Business Analysis Standard replaces The Global Business Analysis Core Standard. Key improvements include:

- Summarized foundational information
- Information about the mindset required to focus on value creation
- Integration of agile business analysis to address hybrid approaches
- Addition of business analysis task cards for better real-world application

The new standard does not change the concepts or text found in the Business Analysis Body of Knowedge (BABOK®) Guide, nor change associated certification handbooks.

The 64-page Business Analysis Standard covers topics such as:

- Understanding Business Analysis
- Mindset for Effective Business Analysis
- Performing Business Analysis
- Tasks and Knowledge Areas
- Glossary and Key Terms

Half of the document is spent in elaborating six Business Analysis task areas:

- Business Analysis Planning and Monitoring
- Elicitation and Collaboration
- Requirements and Designs Life Cycle Management
- Strategy Analysis
- Requirements Analysis and Design Definition
- Solution Evaluation

The Business Analysis Standard is available at no cost. Learn more here.
Request a download.

Join the IIBA to gain to access to additional business analysis resources, e.g., the KnowledgeHub or Research Reports.

Resilience Engineering Association Honors Richard I. Cook

The latest newsletter (Issue #13, December 2022) from the Resilience Engineering Association (REA) continues to honor the legacy of Richard I. Cook for the the invaluable role he played in the foundation and progression of the field of Resilience Engineering.

Multiple articles address this theme:

- Always be helpful, cooperate, and never do SWAG
- Richard Cook's love for Tawain
- The Radical
- The Career, Accomplishments and Impact of Richard I. Cook: A Life in Many Acts
- Avoiding human error in the hospital: Mission possible?
- Cognitive artefacts as a window to ordinary work

SyEN readers are encouraged to reflect on the legacy of this pioneer and apply lessons learned to their own lives and careers.

Access Issue #13 of the REA newsletter.
Learn more abou the REA here.

New Documents for PPI System Engineering Goldmine

PPI's Systems Engineering Goldmine (SEG) continues to grow. Documents recently added to the SEG include:

Integration of Systems with Varying Levels of Autonomy
This technical report begins with a historical background and the evolution of systems engineering. There is a discussion of case studies for land, sea and air vehicles, detailing lessons learned from various programs. The second part of the report continues with a chapter discussing complexity and automation, considering man/machine interface, single vs. multiple vehicles, etc. Then there is discussion of mission management, especially robust design of autonomous systems. This leads to addressing certification issues, such as verification and validation of non-deterministic systems, followed by discussion of issues and challenges. (Source: NATO Research and Technology Organisation)

Practical Suggestions to Successfully Adopt the CMMI V2.0 Development
In this paper, relevant experiences in adopting the new version of the model and the specifics of the pertinent transition journey for an organization are shared. Specifically, information about how new and most significantly changed practice areas can be addressed. Giving details about the novel gap analysis report template that I crafted to be used in analyzing the gaps to become compliant. (Source: Graduate School of Informatics, Middle East Technical University – via ResearchGate)

Recent DoD Trends & System and Software Process Implications
This workshop covers: Acquisition of systems - major defence acquisition programs (MDAPs), Focus on

capabilities and recognition of systems of systems (SoS) and move toward capability portfolios and DoD Capability Area Management (CPMs). (Source: The MITRE Cooperation)

Software Development Cost Estimating Guidebook
The purpose of the Software Development Estimating Guidebook is to provide the cost analyst with a resource manual to use in developing credible software development cost estimates. A realistic estimate is based upon a solid understanding of the software development process and the historical data that forms a framework for the expected values. An estimating methodology that follows a proven process consistent with best practices and Department of Defense (DoD) policies further contributes to estimate validity. (Source: Software Technology Support Center Cost Analysis Group)

Structuring Activity Diagrams
In this paper, elementary behaviours are a priori defined and their equivalent described as behavioural construct patterns. The author claims that modelling tools should propose these behavioural constructs in an "insert" policy to let the Systems Engineers remain at the appropriate behavioural modeling level. (Source: International Federation of Automatic Control)

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

SE Tools Database (SETDB) Continues to Grow

The Systems Engineering Tools Database (SETDB), developed by PPI in partnership with INCOSE, continues to grow as tool vendors add to or update their tool listings. Recent SETDB updates include:

Vendor: SoHaR Incorporated

- RAM Commander: RAM Commander is a comprehensive software tool for Reliability and Maintainability Analysis and Prediction, Spares Optimization, FMEA/FMECA, Testability, Fault Tree Analysis, Event Tree Analysis and Safety Assessment. It covers all widely known reliability standards and failure analysis approaches.
- SoHaR Reliability and Safety Software Suite: The SoHaR software suite consists of a set of integrated tools covering Reliability prediction, Availability, Maintainability Analysis, Safety Assessment, Quality Management, Safety Management, Industrial Process Control and more.

Vendor: Relatics

- Relatics: Relatics is a Model-Based Systems Engineering application for Construction Projects. The Relatics software has been developed for a single purpose: to help people understand the complexity of their challenges so that they can create sustainable solutions. It is designed to enable a large number of different project professionals to maintain control by offering a complete overview of the increasing number of dependencies between all disciplines of today's projects. Relatics crosses boundaries of complexity and helps the world enjoy beautifully engineered buildings, infrastructure, and energy solutions.

Vendor: Beijing Zhongke Fengchao Ltd

- MetaGraph: The multi-architecture modeling tool MetaGraph 2.0 is an architecture modeling and analysis tool. KARMA (Kombination of ARchitecture Model specificAtion) language is a semantic modeling language for a multi-architecture modeling approach (https://doi.org/10.1002/j.2334-5837.2020.00725.x). It is developed by EPFL, KTH, Beijing Institute of Technology, Beijing Zhongke Fengchao Ltd, etc. It supports to formalize multiple system architecture languages, such as SysML, etc. Moreover, KARMA is expected to support descriptions and simulation of different architectural views of systems engineering. KARMA language enables to provide five features: MBSE formalisms, behavior simulation, property verification, dode generation, architecture driven.

Vendor: Capstera

- Capstera's Business Architecture Solution provides an enterprise architecture and capability modeling tool. It enables the capture of semantics, value streams, process models, enterprise meta-data and generate lenses and heat maps to meet the needs of expert practitioners. Features: 1) Define Capabilities 2) Compose Value Streams and Process Maps 3) Draft Specifications to Evolve Capabilities 4) Craft Lenses and Heat Maps 5) Capture Subject Areas and Data Entities 6) Capture Business Motivation and Strategy 7) View and Analyze Reports

Please check out these new and updated systems engineering tool offerings.

Access the SETDB website.

CONFERENCES, MEETINGS & WEBINARS

Registration for the INCOSE International Workshop (IW2023) is Now Open

INCOSE has announced the focus areas for the annual International Workshop (IW2023) to be held as a hybrid event on 28-31 January 2023 in Torrance, California, USA. Attendees at IW2023 will spend 4 days working alongside fellow systems engineering practitioners who are there to contribute their knowledge and experience to advance the state of the systems engineering discipline. Registration for the event may be done here.

Focus areas and associated working sessions for IW2023 include:

Future of Systems Engineering (FuSE)

- Hybrid keynote by Dr. Olivier De Weck
- In-person and open working sessions on Vision & Roadmap, Foundations, Methodology, and Application Extension.
- Virtual sessions will be held after IW to continue this important effort

Model Based Systems Engineering (MBSE)

- Hybrid keynote by Dr. Nancy Leveson
- A full day of critical MBSE updates (SysML v2, MBSE standards, liaisons, …)
- Hybrid workshops on AI/Machine Learning and System Safety

Multi-working group sessions, mobilizing participants from different horizons including:

- An afternoon hybrid session with all Application domain Working Groups reflecting upon the morning FuSE workshop session.
- Smart Cities Initiative who collaborates with MBSE, Architecture, Social Systems, CIPR, System of Systems, Infrastructure, Transportation, and local chapter working groups to progress their efforts.

Outreach sessions, raising awareness beyond each group to increase engagement including:

- INCOSE Service Operations and how partnering with Services contributes to INCOSE products, Working Group effectiveness, and systems engineering.
- The Social Systems working group reaching out to domains beyond traditional systems engineering areas.

IW2023 will be held as a hybrid event to enable in-person and virtual participation, subject to session hosts. Hybrid sessions will strive to include virtual attendees as much as possible, yet individual experiences will vary. IW2023 is open to INCOSE members and non-members.

The full event schedule may be viewed here.

Join INCOSE.

EMEA WSEC Submission Deadline Extended

The INCOSE EMEA2023 submission deadline has been extended. The new deadline for the submission is 10 January 2023.

Taking place from 24-26 April 2023, the hybrid workshop held in Seville is focused on using the power of SE to target societal challenges per the INCOSE 2035 vision to aspire for a better world. The event is inspired around applying systems engineering to the United Nations Sustainable Development Goals (UN SDGs) and focusing workshop efforts on solving highly complex and chaotic systems.

The following content is invited for the event:

- Full content
  - Papers: See Paper Preparation Guidelines here and see Paper Template here
  - Panel sessions: See Panel / Roundtable / Debate Preparation Guidelines here
  - Tutorials: See Tutorial Preparation Guidelines here
- Abstracts only
  - Paperless presentations: See Paperless Presentation PowerPoint Template here
- Workshops (due for submission by 28th February 2023):
  - See the Workshop Application Form here

The technical program may be viewed via the following link.

Call for Abstracts: 2023 Systems Thinking and Modelling Symposium (System Dynamics Society, Oceania Chapter)

The Oceania Chapter: 2023 Systems Thinking & Modelling Symposium is taking place at the University of Sydney (and online) on 12 February from 12:00 PM To 05:00 PM AEDT. The System Dynamics Society as the host of the event is seeking abstracts from practitioners, researchers, and students. The event has extended its deadline for submissions to 11 January 2023.

The event is geared to have an expert panel to provide suggestions and comments on students' research and a 2.5-hour intro to SD session, among other subevents. The event is free to participants, but catering options will be made available at the expense.

Abstracts may be submitted via the following link.

PDMA Webinar: A Product Owner's Journey from Scribe to Entrepreneur

The St. Louis (Missouri, USA) chapter of the Product Development Management Association (PDMA) will host a webinar on 7 February 2023 titled "A Product Owner's Journey from Scribe to Entrepreneur".

Don McGreal, co-author of the best-selling book, The Professional Product Owner: Leveraging Scrum as a Competitive Advantage, will share his journey from a 'scribe' toward 'entrepreneur'. In McGreal's view, scribes spend their days specifying and communicating requirements while entrepreneurs focus more on strategy and ROI.

This is a free event for both PDMA members and non-members alike. Learn more.
Register here.

Learn more about PDMA here.

Call for Submissions and Registration: 2023 International System Dynamics Conference

Registration is open for the 2023 International System Dynamics Conference (ISDC2023), scheduled for 23-27 July 2023. While ISDC2023 is a hybrid event, the in-person portion will take place in Chicago, Illinois, USA with a limited in-person capacity of 300 attendees.

The theme of ISDC2023 is *Adapting in the Face of Change*. Papers are invited that address the following questions:

- What are the drivers of current sociological behaviors and how do we achieve the new equilibriums we are seeking?
- How do models help us build both hindsight about past behaviors and dynamic hypotheses about our future?
- How do applications of System Dynamics models help shape policies that seek to build an equitable, sustainable future that includes health and well-being for both people and ecosystems?

Submissions should highlight the use of System Dynamics including rigorous quantitative and qualitative modeling and new approaches that address current global challenges such as pandemics, climate change, social and racial inequities, nationalist politics, and a rapidly urbanizing population. Conference threads include:

- Business and Strategy: Features applications of System Dynamics in businesses and organizations including strategy development, profitability, marketing, competitive dynamics, product launches, project dynamics, and accounting.
- Diversity: applications of System Dynamics on topics such as gender, race or ethnicity, class, age and ability, etc.; racial justice work that addresses issues including, but not limited to, structural racism, interpersonal discrimination, or institutional bias; and submissions that demonstrate diverse experiences with System Dynamics.
- Economics: Features papers improving understanding of economic dynamics including macroeconomics, microeconomics, trade, business regulation, economic development, economic policy, insurance, and risk management.
- Environment and Resources: Emphasizes dynamics of natural resource management and policy for the environment including food, water, energy and climate change, pollution, environmental laws and regulation, and ecology.
- Health: Applies System Dynamics to issues related to health and health care including health policy, health services research, population health, and physiology.
- Learning and Teaching: The manner in which system skills are taught and learned including pedagogy, learning experiments, curriculum development, workshop design, and interactive activities designed to be part of an educational experience.
- Operations: Includes business and other process operations including capacity management, quality control, operations management, supply chains, workflow, queuing, and workforce planning.

- Methodology: Welcomes contributions to System Dynamics modeling and simulation including quantitative and qualitative aspects of model development, model analysis, validation, graphical presentation formats, computational techniques, and integration of System Dynamics with other approaches such as Artificial Intelligence and Predictive Analytics, among others.
- Psychology and Human Behavior: Explores the dynamics within and between social groups, including social environments or individual psychological factors, and spanning families, organizations, and societies.
- Public Policy: Covers issues including governance, social welfare, equity, justice, political science, urban dynamics, and infrastructure.
- Stakeholder Engagament: Emphasizes engaging and influencing stakeholders through participatory activities such as group model building, facilitation, facilitated modeling, games, and management flight simulators, with emphasis on assessing the impact of the engagement.
- Security, Stability, and Resilience: Investigates issues related to security, stability, and resilience, including defense, social and international conflict, military operations, insurgency, counterinsurgency, cybersecurity, disinformation, safety, disaster management, peace engineering, justice, (financial and economic) crime, policing, incarceration, socioeconomic inequality, and food-energy-water security.
- Transport and Mobility: Covers all aspects of transportation systems and mobility, including transport and urban planning policies; new services, technologies, or business models; decarbonization and sustainable mobility; transport and health; and freight and logistics.

The window for submissions is 24 January through 21 March 2023. Authors will be notified of acceptance by 11 May.

Types of submissions sought include:

- Research Paper
- Practitioner Application
- Workshops
- Student-Organized Colloquium
- Other, e.g., Roundtable, Meeting

View detailed Submission Instructions.
Those who desire to attend in person and who need a visa to enter the United States should request an Invitation Letter here.

Learn more about ISDC2023 here.
Register for ISD2023.

Registration Open for BA Istanbul Conference

BAISTANBUL

Registration is open for the BAIstanbul Conference, scheduled for 16-17 February 2023. Hosted by BA-Works, BAIstanbul is endorsed by the International Institute of Business Analysis™ (IIBA) and will provide opportunities for business analysis professionals from Turkey and Southeast Europe to engage with a network of international experts in the field.

The theme of BAIstanbul 2023 is *Driving Digitalization – Design the Future*. Topics to be addressed include:

- Agile Analysis
- Customer Focused Innovation
- Future Compentencies
- Leading Change
- Product Ownership
- Strategic Design
- Sustainability

Learn more about BAIstanbul 2023.
Register here.

INCOSE New Zealand Webinar: Requirements schemas for large multidisciplinary projects

On 22 November 2022 the INCOSE New Zealand chapter hosted a webinar on *Requirements schemas for large multidisciplinary projects*. John Welford of WSP shared his insights on this topic, previously presented at the Engineers Australia Systems Engineering Test & Evaluation (SETE) Conference.

Abstract:
Whilst international standards and best practice documents provide high-level guidance in the structure and delivery of Requirements Management and Verification and Validation activities, there is still room for considerable variation in the fine details of implementation; this variation often occurs across even relatively similar projects, based on the delivery teams, organisations and individuals involved. Seemingly minor decisions in requirements structure made early in the project lifecycle can have significant impacts in terms of the management and verification effort needed later in the works, particularly where projects are large, and delivery is spread across multiple disciplines.

This work discusses several options for structuring requirements schemas, focussed on the delivery of large multidisciplinary infrastructure projects, and in support of a move towards increasingly model-based delivery. It specifically discusses requirements development, requirements allocation, and design verification against requirements. Recent New Zealand rail and infrastructure projects, City Rail Link and the Interislander Resilient Connection, are used as examples to highlight differences in approach and present pros and cons.

View John Welford's talk here.
Access the slides.

Learn more about the INCOSE New Zealand chapter.

Webinar: Bridging Systems Engineering and Multi-Fidelity Analytical Models

Vitech (subsidiary of Zuken Americas) has posted a recording of a recent webinar, aimed at systems engineering practititioners, titled *Bridging Systems Engineering and Multi-Fidelity Analytical Models*. The presenters for this topic were Steve Cash, Director of Customer Enablement at Vitech and Alexandre Luc, Application Engineer, Ansys. Brian Selvy, Chief Innovation Officer at Vitech, served as moderator.

Abstract:
Systems engineering in all industries has been increasingly turning to Model-Based Systems

Engineering (MBSE) to meet market expectations. This helps in designing ever more complex systems while reducing development cost and time, maximizing system performance, and improving product safety. By aligning people, processes, and technology around a single product vision, MBSE promises to dramatically reduce the cost and risk of developing complex systems.

The challenge is connecting systems engineering architectural models to detailed engineering analytics to achieve the full potential of MBSE.

We will discuss an approach to unlock the promise of MBSE by connecting a Vitech GENESYS system model with analysis/simulation models and workflows, assuring that the product vision remains in sync with the underlying analysis throughout the product lifecycle. This allows engineers to validate verify requirements, simulate system behavior, and carry out Multi-Disciplinary Analysis & Optimization (MDAO) to optimize system design at any time during the design process. Rigorous traceability between requirements, design, and analysis results in improved quality.

Learning goals for this webinar included:

- How the connection between the systems architectural model and the detailed analytics is defined in Vitech's GENESYS
- How engineers can use ModelCenter to automate the execution of multiple engineering analysis tools and to create unified and reusable automated simulation workflows
- How engineers can use ModelCenter MBSE with GENESYS to connect the automated workflows to a system architecture model to ensure an end-to-end requirements traceability.

Request webinar access here.

Webinar: Building an Open Digital Thread

On 30 November 2022, Dr. Dirk Zwemer, President of Intercax, presented a webinar that introduced the vision of an Open Digital Thread, described the most important characteristics of this construct and provided examples of range of potential use cases. According to Dr. Zwemer, the Open Digital Thread concept offers a practical approach to building an ASSOT (authoritative single source of truth) out of a heterogeneous set of engineering models. The Open Digital Thread enables data consistency, shared across a federated set of digital engineering, design, and program management tools. By providing access to a complete data set and contextual information, the Open Digital Thread may reduce errors, shorten development time and yield better design decisions.

Intercax and Zuken/Vitech, are partnering to show how tools such as Vitech GENESYS, Zuken DS-E3, and Zuken DS-CR can be integrated into the Intercax Syndeia digital thread platform.

These integrations create new capabilities to:

- Access the contents of multiple repositories.
- Create a network of relations with ALM, PLM, and other engineering repositories.
- Transform, analyze and report data through data science and business analytics platforms.

SyEN North American readers may request webinar access here.

Webinar: Agile Systems Engineering - Managing Models with Pipelines

On 30 November 2022, Daniel Siegl of LieberLieber Software presented a webinar on how to enable true agile modeling with processes from Software Engineering. Titled "*Agile Systems Engineering - Managing Models with Pipelines*", the presentation focused on the industry challenge of managing complexity and proposed a three-pronged approach consisting of:

- Model Based System Engineering
- Configuration and Change Management
- Agile Development using "Pipelines"

Download the slides here.
View the presentation video.

Recent MapleMBSE Webinars

Maplesoft hosted two MBSE-related webinars in November and has posted the webinar videos online for open-access viewing. Both webinars highlighted the capabilities of Maplesoft's MapleMBSE software to deal with complexity and to improve system modeling efficiency.

Using MapleMBSE to Manage Domain-Specific Stereotypes in SysML Models
On 15 November 2022, David Hetherington, Principal Systems Engineer with System Strategy, Inc., shared how to improve safety, reliability, security, and other domain specialty teams in CATIA No Magic MBSE projects, by sharing digital resources using customized stereotypes.

Abstract:
A key goal of systems engineering is to create a shared vision for the system among a diverse set of stakeholders. Model-based systems engineering seeks to create a common shared digital resource so that stakeholders can perform domain-specific engineering activities such as safety or cybersecurity engineering while directly and digitally accessing the shared assumptions about structure, behavior, interfaces, and relationships for the system.

One very common SysML technique for domain specialty teams in this sort of environment is to create and deploy a custom profile of UML stereotypes that can be added to elements in the common model to attach domain-specific information to the common model. For example, a safety team might create a stereotype called «safety part» that would be applied to specific part instances of a block. The block "compute ECU" might be somewhat generic. Some part instances of that block in the vehicle might be for controlling the entertainment displays for the rear-seat passengers. Others might be for controlling the driver assistance features. The later block usage would be of concern to the safety team and would be flagged with the «safety part» stereotype.

In a typical implementation the «safety part» could contain attributes for a number of different safety aspects for the part such as:

- Safety Integrity Level (SIL or ASIL)
- Rationale for assignment of the SIL/ASIL
- Failure Rate
- Date of safety review

Such specialized stereotypes can be managed to some extent directly in the CATIA No Magic tools.

However, the fundamental information such as failure rates is frequently embedded in a large base of legacy spreadsheets and or databases. Often the exact value needs to be derived from a series of factors that are easy to manage in a spreadsheet, but are beyond the scope of the SysML model.

View this webinar.

Configuring MapleMBSE: An Introduction to Query Path Expression(QPE) for Capella
On 30 November 2022, Bharani Mohan, MapleMBSE Product Manager, shared how interactions between the Capella system model and Subject Matter Experts (SMEs) can be simplified by using MapleMBSE to create different task-specific views.

Abstract:
MapleMBSE gives systems engineers the ability to create customized views (Functional Decomposition, Traceability, Safety Analysis, etc.) for each stakeholder, showing them only what they need to get their tasks done. These simplified interfaces make it easy for every stakeholder to contribute to the model of the overall system.

In this webinar, we will see how we can use MapleMBSE's model transformation language to create different task-specific views by which SMEs can interact with a Capella model using the spreadsheet interface.

View this webinar.

View additional recorded webinars about Maplesoft products.
Subscribe to the Maplesoft event mailing list.

Learn more about MapleMBSE.

Webinar: Accelerating the Journey to Net Zero With Regional Digital Twins

Digital Twin Consortium (DTC) is a global ecosystem of users driving best practices for digital twin usage and defining requirements for new digital twin standards.
DTC defines a digital twin as *a virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity*.

On 30 November 2022, DTC hosted a webinar titled "Accelerating the Journey to Net Zero With Regional Digital Twins" delivered by presenters:

- Robert Harwood, Chief Operating Officer, Slingshot Simulations
- Alex Trout, Application Engineer, Electric Places

Abstract:
For regional stakeholders, from policymakers to planners, engineers, and the general public, many intervention options are available to achieve stated regional net zero objectives. With finite and constantly pressured finances, key challenges include determining the optimum combination of interventions for local conditions and delivering the maximum, quantified value-add to the region while ensuring representative engagement across the impacted region.

This webinar will look at how Electric Places and Slingshot Simulations developed a digital twin of a four-hundred square mile UK regional local authority to integrate, link, and contextualize the siloed data relevant to high-impact net zero interventions.

Attendees will learn how to run simulations to examine the future impact of a diverse set of intervention scenario options and create compelling visualisations for broad-based stakeholder engagement - and ultimately drive change in the real world.

Summary of key points:

- Accelerating the transition to net zero is critical – multiple social, political and legal forces are driving the agenda
- Data is key to making better decisions faster. However, pervasive connectivity has created a data deluge resulting in siloed, disconnected decision making
- Digital twins, proven in multiple industry sectors, can play a critical role helping towns, cities and regions achieve their stated goals
- A solution for North Northamptonshire has been developed by combining digital twin expertise with net zero intervention know how
- This is being used to accelerate and prioritize strategic intervention decision making and mobilize key stakeholders to action

View the webinar here. Download the presentation.
View other DTC webinars here.
Learn more about the Digital Twin Consortium (DTC).

Upcoming PPI Live-Online ™ Systems Engineering Five Day Courses

Click here to view the full schedule or register for an upcoming course.

P006-903-1	Europe CET 9:00 (UTC +1:00) PPI Live-Online	09 Jan - 13 Jan 2023
P006-903-2	United Kingdom GMT 8:00 (UTC +0:00) PPI Live-Online	09 Jan - 13 Jan 2023
P006-903-3	South Africa SAST 10:00 (UTC +2:00) PPI Live-Online *(Only available in South Africa)*	09 Jan - 13 Jan 2023
P006-904-1	Turkey TRT 8:00 (UTC +3:00) PPI Live-Online	16 Jan - 20 Jan 2023
P006-904-2	Saudi Arabia AST 8:00 (UTC +3:00) PPI Live-Online	16 Jan - 20 Jan 2023
P006-905-1	North America EST 8:00 (UTC -5:00) PPI Live-Online	16 Jan - 20 Jan 2023
P006-905-2	South America BRT 10:00 (UTC -3:00) PPI Live-Online *(Only available in South America)*	16 Jan - 20 Jan 2023
P006-906-1	Asia SGT 5:00 (UTC +8:00) PPI Live-Online	13 Feb - 17 Feb 2023
P006-906-2	Oceania AEDT 8:00 (UTC +11:00) PPI Live-Online	13 Feb - 17 Feb 2023
P006-907	London, United Kingdom GMT 8:30 (UTC +0:00) In-Person	20 Feb - 24 Feb 2023
P006-908	Las Vegas, United States of America PST 8:00 (UTC -8:00) In-Person	06 Mar - 10 Mar 2023
P006-909-1	North America EDT 10:00 (UTC -4:00) PPI Live-Online	20 Mar - 24 Mar 2023

FEATURE ARTICLE

Reflections on INCOSE Systems Engineering Principles

by John Fitch (PPI Presenter and Principal Consultant)

Email: jfitch@ppi-int.com

Introduction

In August 2022, the International Council on Systems Engineering (INCOSE) published a new technical product, Systems Engineering Principles.[1] This 45-page document was the result of multi-year efforts by the INCOSE Systems Engineering Principles Action Team, supported by numerous other INCOSE members and peer reviews by sister societies including American Institute of Aeronautics and Astronautics (AIAA), the Institute of Electrical and Electronics Engineers (IEEE), and the U.S. National Defense Industrial Association (NDIA).

The document begins with a review of three decades of history associated with systems engineering principles which recounts how numerous research studies yielded differing, but often complementary lists of principles. The Principles Action Team built upon this rich legacy (which included PPI's own set of principles to be discussed later) as the foundation for this latest work product.

Definitions are provided to clarify the subtle distinctions between the terms used in this space:

> *Principle*: a fundamental truth or proposition that serves as the foundation for a system of belief or behavior or for a chain of reasoning. Principles must satisfy the following criteria:
>
> - Transcend life cycle, system type and context
> - Inform a world view on systems engineering
> - Not be how-to statements
> - Be supported by literature and/or widely accepted in the profession
> - Be focused, concise, and clear
>
> *Heuristic*: a form of guidance propositions emerging from practice in a given context or area.
>
> *Hypothesis*: a potential statement of principle that has varying support and that research can prove or disprove.
>
> *System principles*: Principles that address the functioning of a system, looking at the scientific basis for a system and characterizing this basis in a system context.
>
> *Systems engineering principles*: Principles that address the engineering approach to developing and operating a system.

INCOSE Systems Engineering Principles

The sections that follow present the 15 INCOSE principles and 3 hypotheses and associate them with two sets of principles that PPI delivers as part of its training courses.

- 15 Systems Engineering principles (SE1 … SE15) [2]
- 23 Systems Engineering Management principles (SEM1 … SEM23) [3]

PPI's principles, in general, do not directly address *system principles* as defined in the Introduction – they focus on systems engineering and the management thereof. However, where an INCOSE principle is based on systems science, such science often provides the basis for PPI's application-focused principles. For convenience, tables of the PPI principles are provided near the end of this article with an initial mapping to the INCOSE principles and hypothesis that are detailed below.

PRINCIPLE 1: Systems engineering in application is specific to stakeholder needs, solution space, resulting system solution(s), and context throughout the system life cycle.

This principle broadly states the need for tailoring of systems engineering practices to match the nature of the product/system being engineered, including its environment and context.

PPI's Systems Engineering Management (SEM) Principle 13 echoes this belief:

- SEM13: Apply the systems engineering process elements selectively within the context of sequential, incremental, evolutionary and/or the risk and opportunity-driven styles of development. Design the development process to match the nature of the problem, using the SE process elements as building blocks.

SEM Principles 9-12 elaborate the applicability of various development strategies to different engineering contexts:

- SEM9: Use sequential development (waterfall, grand design, "big bang", etc.) for development, where requirements (etc.) are able to be well defined and stable, and solutions are relatively simple or well understood, i.e. the risks due to technology & complexity are low.
- SEM10: Use incremental development where requirements (etc.) can be well defined and stable, but solutions have risk due to technology and/or due to complexity.
- SEM11: Use evolutionary development where requirements (etc.) are as well-defined as is possible in the circumstances, but remain inadequately defined from the point of view of the enterprise, or are subject to change that the enterprise needs to accommodate.
- SEM12: Use a stage-based, stage gate, risk and opportunity-driven style of development as an overall strategy for development (sometimes referred to a Spiral development) where risk is significant (note that incremental and evolutionary are special cases of spiral).

Adapting the systems engineering process and scaling the effort to match the problem at hand (e.g., business context) is also addressed in SEM Principles 14-15 and 22:

- SEM14: Consider the use of agile development where usable increments of product are valuable and requirements may evolve, but not in ignorance of what is known or knowable about the problem at the start of development.
- SEM15: Use the lean development approach (apply the lean enablers) to optimize value to the end customer by eliminating waste from the development process.
- SEM22: Choose to do things only in the rational expectation of producing a better result by doing so (on the balance of probabilities). Choose to NOT do things for EXACTLY the same reason.

The consistent and resounding message of these principles is that systems engineering is not a one-size-fits-all proposition.

PRINCIPLE 2: Systems engineering has a holistic system view that includes the system elements and the interactions amongst themselves, the enabling systems, and the system environment.

This principle takes a system science perspective that marries the definition of a system (multiple elements interacting for a purpose) with the importance of taking a holistic view of this system, the enabling systems that support its full lifecycle and the understanding of its broader environment. Category theory is used to provide a mathematical foundation for this principle. The emergent properties of the whole system go beyond the properties of individual system elements or functions, such that systems engineering (done according to this principle) focuses primarily on the interactions between system elements and the system behaviors, planned or unplanned, that emerge from these interactions.

PPI shares this holistic definition and view of system and recognizes that such a perspective must be applied recursively when engineering a system of any significant complexity. Each level of system design translates a problem definition into a holistic solution comprised of multiple interacting elements. That solution description becomes the problem definition for the next-level designer. By implication, it is important to maintain the problem-solution distinction at each branch of the system decomposition:

- SE5: Maintain a distinction between the statement of the problem and the description of the solution to that problem, for the system of interest, and for each subsystem/component/system element of that system.
- SEM6: Design a solution by dividing the big problem into a set of individually sufficiently well-defined smaller problems, i.e., by defining the required characteristics of each element of the solution (including both product {hardware and software, etc.} and process elements, as applicable).

Principle 2 also introduces the concept of an enabling system whose interactions with the system of interest must be taken into account to enable a holistic understanding of the system across its lifecycle. PPI principles promote the value of the concurrent engineering of enabling systems:

- SE8: Develop solution descriptions for enabling systems concurrently and in balance with the solution description for the system of interest.
- SEM16: Use a concurrent engineering approach to simultaneously engineer the system of interest as well as all relevant enabling systems.
- SEM19: Recognize that the engineering system is a system like any other system. Engineer it as such.

Failure to concurrently engineer (collaboratively decide the design of) enabling systems such as engineering, manufacturing, deployment, support or end-of-life is a proven recipe for development project rework, delays and high lifecycle cost.

PRINCIPLE 3: Systems engineering influences and is influenced by internal and external resource, political, economic, social, technological, environmental, and legal factors.

This principle elaborates on the range of stakeholders and their interests that should be accounted for when defining a problem and engineering a solution and emphasizes the significance of non-technical aspects of the system that are often overlooked. Designers also need to be aware of the influence, sometimes subtle, of the developing organization’s structure and culture on the design process.

PPI doesn't promote an explicit principle to broaden the range of stakeholders, rather focuses on the adequacy of problem definition created through a set of 17 system requirements analysis techniques. Beyond the initial identification of stakeholders (step 1), Context Analysis is used to detail the external systems and stakeholders who will interact with the system of interest across its lifecycle and to characterize the nature of such interactions. What the INCOSE document terms as PESTEL factors (political, economic, social, technological, environmental, and legal) should be uncovered in Context Analysis or through a later checklist technique known as Other Constraints Search. PPI's beliefs on the adequacy of problem definition are captured in three principles:

- SE1: Capture and understand the requirements, measures of effectiveness and goals (the problem) before committing to the solution.
- SEM4: Establish an objectively adequate problem definition before committing significant resources to design and development, subject to any need for evolutionary development (see below).
- SEM5: Ensure that, for those performing requirements engineering functions, sound requirements engineering principles are understood and embraced.

PRINCIPLE 4: Both policy and law must be properly understood to not overly constrain or under constrain the system implementation.

INCOSE Principle 4 expands on the influence of policy and legal constraints on the systems engineering process, including the need for additional effort and care when interpreting such expectations. PPI utilizes the requirement analysis principles and practices mentioned for INCOSE Principle 3 to address this concern.

PRINCIPLE 5: The real system is the perfect representation of the system.

This systems science principle highlights the limitations of all system models in fully expressing system behaviors and properties. Only the real system, deployed operationally across the full range of environments and across its full lifecycle, can exhibit the full range of required system characteristics.

Practically speaking this principle influences the selection of a development strategy. Incremental and spiral (stage-based, stage gate, risk and opportunity-driven) development strategies promote the development of solutions in ever-more-complete stages that move closer to the real system in scope and behavior.

- SEM10: Use incremental development where requirements (etc.) can be well defined and stable, but solutions have risk due to technology and/or due to complexity.
- SEM12: Use a stage-based, stage gate, risk and opportunity-driven style of development as an overall strategy for development (sometimes referred to a Spiral development) where risk is significant (note that incremental and evolutionary are special cases of spiral).

The uncertainty inherent in partial systems is recognized in this principle as one contributor to the need for some level of iteration in the design process:

- SE10: Be prepared to iterate in design to drive up overall effectiveness, but not at the expense of the requirements.
- PRINCIPLE 6: A focus of systems engineering is a progressively deeper understanding of the interactions, sensitivities, and behaviors of the system, stakeholder needs, and its operational environment.

This principle (and its 8 sub-principles not elaborated in this article) consider system engineering from the perspective of an organization's totality of understanding of the system that emerges from both system development and operations. Design decisions elaborate the system elements and their interactions and enable the engineers to balance performance, cost, schedule, and risk. System models that are used to inform decision decisions are validated by operational experience and refined as needed. Design decisions create derived requirements that drive the next level designs. Lessons learned during development or operations should be fed back to influence future system upgrades.

The incremental and spiral development strategies (see SEM10 and SEM12, above) assume that insights gained from each development stage will grow the team's understanding of the problem and the evolving solution. The growth in system understanding is also anticipated in the branching decomposition processes implied by:

- SE5: Maintain a distinction between the statement of the problem and the description of the solution to that problem, for the system of interest, and for each subsystem/component/system element of that system.
- SEM6: Design a solution by dividing the big problem into a set of individually sufficiently well-defined smaller problems, i.e., by defining the required characteristics of each element of the solution (including both product {hardware and software, etc.} and process elements, as applicable).

PRINCIPLE 7: Systems Engineering addresses changing stakeholder needs over the system life cycle.

Systems engineering processes must deal with changing stakeholder expectations, reflected in updates to mission and system requirements.

PPI accounts for this change management reality by recognizing the value of configuration management (baselining), evolutionary development strategies and agile development practices:

- SE6: Baseline each statement of the problem (requirements, measures of effectiveness and goals set) and description of the solution to that problem (design). Control changes to requirements and design.
- SEM11: Use evolutionary development where requirements (etc.) are as well-defined as is possible in the circumstances, but remain inadequately defined from the point of view of the enterprise, or are subject to change that the enterprise needs to accommodate.
- SEM14: Consider the use of agile development where usable increments of product are valuable and requirements may evolve, but not in ignorance of what is known or knowable about the problem at the start of development.

PRINCIPLE 8: Systems engineering addresses stakeholder needs, taking into consideration budget, schedule, and technical needs, along with other expectations and constraints.

This principle highlights the need to balance technical, budget, schedule, and other constraints in developing a solution that best meets stakeholders' needs. PPI principles SE1-SE4 set up this balancing capability by promoting comprehensive system requirements analysis. Principles SE5 and SE7 directly address the balancing process of determining a best fit solution to the total set of stakeholder needs.

- SE1: Capture and understand the requirements, measures of effectiveness and goals (the problem) before committing to the solution.
- SE2: Try to ensure that the requirements are consistent with what is predicted to be possible in solutions, at the time of required supply, i.e., are feasible.
- SE3: Treat as goals desired characteristics that may not be feasible, but not at the expense of the requirements.
- SE4: Define system requirements, measures of effectiveness, goals and solutions having regard to the whole of the (remaining) life cycle of the system of interest.

- SE7: Identify and develop descriptions of solutions alternatives (designs) that are both feasible (i.e., can meet requirements) and potentially are the most effective. Put aside from further consideration, as potential solutions, all other alternatives (unless the assessment of that potential solution changes).
- SE11: Decide between feasible solution alternatives based on evaluation of the overall effectiveness of each of these alternatives. Limit alternatives to be evaluated to those that have potential to be the most overall effective. Take risk and opportunity into consideration in the evaluation.

PPI principles also clarify the stakeholders for whom value is being optimized for different system and business contexts:

- SEM1: The supplier purpose of SE management in commercial contexts is to maximize value to the enterprise by optimizing value to the customer.
- SEM2: The purpose of SE management for internal projects is to maximize value to the internal customer within the constraints that exist.

PRINCIPLE 9: Systems engineering decisions are made under uncertainty accounting for risk.

This principle reflects the reality of uncertainty in all aspects of the system development process. Design decisions are made using estimates of the performance of various alternatives against evaluation criteria derived from system requirements and design goals. At the point of decision, the design team's understanding of each alternative's behavior and effectiveness is always incomplete, limited by:

- The completeness and common understanding of the alternative's description and logical, physical models, behavioral and performance models.
- The design team's experience with similar problem domains and solution technologies.
- The quality and fidelity of the system modeling methods being used to inform the effectiveness evaluation process.
- The coverage and understanding of the full range of possible use cases and environments that the system will experience across its lifetime.

Systems engineering methods account for the reality of uncertainty by various risk-aware and opportunity-aware processes:

- Incorporating uncertainty in the decision analysis process.
- Developing risk mitigation and opportunity growth plans.
- Tracking risk mitigation and opportunity growth actions into subsequent development processes.

In addition to the statement "Take risk and opportunity into consideration in the evaluation" within PPI principle SE11 (see above), PPI elaborates on the role of uncertainty, risks, and opportunities by introducing the concept of risk-adjusted expected effectiveness as the ultimate decision-making "equation":

- SEM17: Select between (feasible) design alternatives based on the evaluation of risk-adjusted expected effectiveness to applicable stakeholders, i.e., on expected overall effectiveness. Note: "expected effectiveness" refers to effectiveness that incorporates uncertainty, reflecting risk and opportunity.

PRINCIPLE 10: Decision quality depends on knowledge of the system, enabling system(s), and interoperating system(s) present in the decision-making process.

This principle highlights the dependence of design decision-making quality on organizational factors. In general, increasing the number and diversity of the participants in decision-making reduces the potential for bias and helps to uncover missing but relevant information. Decision-making representation from stakeholders that span the full system lifecycle is an antidote to making design choices that are inconsistent with the needs and constraints associated with enabling or interoperating systems.

Beyond the decision-enabling principles addressed under INCOSE principles 8 and 9 above, PPI principles account for the organizational aspects of design decisions:

- SEM21: Use empowered, product-oriented, multidisciplinary team structures for more complex engineering efforts.

PRINCIPLE 11: Systems engineering spans the entire system life cycle.

This principle asserts that systems engineering is full lifecycle process that encompasses all activities needed to:

- Gain an understanding of the problem.
- Conceive, evaluate, select and detail (typically as models) the solution.
- Verify that the solution meets its requirements.
- Validate that the solution meets the stakeholder needs.
- Support system deployment, operations, maintenance, and retirement.

PPI echoes this understanding of systems engineering's scope by emphasizing lifecycle coverage (including concurrent design of enabling systems that span the lifecycle) in several principles:

- SE4: Define system requirements, measures of effectiveness, goals and solutions having regard to the whole of the (remaining) *life cycle* of the system of interest.
- SE8: Develop solution descriptions for *enabling systems* concurrently and in balance with the solution description for the system of interest.
- SE12: Subject to level of risk, independently *verify* work products (is the job being done right?)
- SE13: Subject to level of risk, *validate* work products from the perspective of the stakeholders whom the work products serve (is the right job being done?)
- SEM16: Use a concurrent engineering approach to simultaneously engineer the system of interest as well as all relevant enabling systems.
- SEM19: Recognize that the *engineering system* is a system like any other system. Engineer it as such.

Note that PPI extends the concepts of verification and validation beyond the system of interest to any engineering work product created in support of development and lifecycle support of the system.

PRINCIPLE 12: Complex systems are engineered by complex organizations.

Systems engineering must deal both with a complex system and the complexity of the organization(s) that are developing and supporting the system across its lifecycle. Social systems comprised of diverse human agents interacting through technology have less predictable behavior than cyber-physical systems that operate according to natural laws and structured software code.

The author is reminded of a conference presenter (Vice President of Engineering) that asserted that the organizational system that designed an automobile (namely the Ford Mustang) was more complex (in terms of number of actions, participants, and interactions among them) than the vehicle itself.

PPI principles promote multiple approaches for addressing the impact of organizational complexity and social dynamics:

- SEM19: Recognize that the engineering system is a system like any other system. Engineer it as such.
- SEM20: Use a product-oriented structure of products and related services, Project Breakdown Structure, also called Work Breakdown Structure (PBS/WBS), as a framework for definition, cost estimating, scheduling, risk and opportunity analysis, measurement, assignment of responsibility, team design and reporting.
- SEM21: Use empowered, product-oriented, multidisciplinary team structures for more complex engineering efforts.

PPI takes it as good news that the management of engineering for complex systems is not beyond the reach of proven management best practices:

- SE14: The act of managing is needed to plan and implement the effective and efficient transformation of requirements and goals into solutions.
- SEM18: Manage the engineering - plan, organize, motivate, assess, control.
- SEM23: General management, project management and engineering management principles are all generally applicable to systems engineering management.

PRINCIPLE 13: Systems engineering integrates engineering and scientific disciplines in an effective manner.

Systems engineering rests on a scientific foundation. Engineers use their knowledge of causality to inform their understanding of the problem and develop solutions. Systems engineering is an integrative discipline that blends the knowledge of traditional engineering and scientific disciplines (electrical, aeronautical, mechanical, civil, chemical, physics, social science, etc.).

PPI principles note that successful engineering depends on the combination of process skills with relevant knowledge from multiple engineering and scientific disciplines. For example, knowledge about solution technologies is essential for requirements feasibility and design synthesis and evaluation. Systems engineering process skills, e.g., requirements traceability or physical architecture modeling, are insufficient to assure effective solution design.

- SEM5: Ensure that, for those performing requirements engineering functions, sound requirements engineering principles are understood and embraced.
- SEM7: Apply design skills and technology knowledge in creating requirements.
- SEM8: Regard knowledge of relevant technologies, and the creativity and attitudes to apply that knowledge in a team environment, as indispensable ingredients of effective engineering.

PRINCIPLE 14: Systems engineering is responsible for managing the discipline interactions within the organization.

This principle appears to place the responsibility for managing interdisciplinary interactions during development upon an organizational unit, systems engineering, or named role, systems engineer.

> "A concern of the *systems engineer* is how these units interact as part of system knowledge and understanding (system information) flows through the organization. The *systems engineer* works with project management and line management to resolve identified system information gaps or barriers in the organizational structure, as these gaps and barriers will lead to flaws in system design, manufacturing, and operation."

"*Systems engineers* are responsible for understanding how the organizational structure and culture affect the flow of information about the system. The *systems engineer* ensures proper interaction between the engineering disciplines as they produce their aspect of the system."

On this point, PPI's principles diverge in tone, if not in fact, from INCOSE Principle 14. Systems engineering is not an organization in PPI's model – it's a set of principles and associated methods or practices, applied to projects by all involved. There is certainly a need for interdisciplinary coordination and holistic systems-level thinking; in some projects those functions may be best performed by an organizational unit called Systems Engineering, staffed with practitioners with Systems Engineer as a job title. The demand for such organizational formality may correlate with project size and complexity.

However, the role of managing discipline interactions doesn't have to be bequeathed to a distinct set of humans known as Systems Engineers or an organizational unit known as Systems Engineering. Better if all engineers and contributors to a system development project had an understanding of systems engineering principles and mastery over associated practices. As noted before, the structure of a project's engineering system (including the organization design) is the product of its design as an enabling system; the resulting structure must balance multiple objectives and constraints.

- SEM3: Establish a culture in which the application of systems engineering principles is embedded.
- SEM19: Recognize that the engineering system is a system like any other system. Engineer it as such.

PPI's vision for systems engineering targets a future in which most engineers (or solution developers in any domain) learn systems engineering principles and practices during their undergraduate studies, if not earlier. Every engineer should be a systems engineering practitioner.

In part, the INCOSE Systems Engineering Vision 2035 shares this view. In the section titled Specific Recommendations (to Systems Engineering Community) – Roadmap for Progress, two Advancement in Education goals mirror this perspective:

- Engineering continuing education and pre-college education integrates select systems engineering concepts and systems thinking into their curricula.
- Systems Engineering community and accreditation bodies team to add systems engineering and system concepts into all engineering accreditation criteria.

Not to be too dogmatic here, PPI SyEN understand that the process of changing the language of the global engineering and educational communities away from disciplined-focused titles to principles, practices and roles won't be finished any time soon. The use of *systems engineer* as a shorthand for *systems engineering practitioner* will likely continue for at least a few more decades.

PRINCIPLE 15: Systems engineering is based on a middle range set of theories.

There is no unified theory that serves as the foundation for systems engineering. Four theoretical disciplines (systems theory, system physics/logic, mathematics, and sociology) combine to provide such a foundation. None of these disciplines has a unified theory.

Systems exist as one or a combination of physical systems, logical systems, and social systems. System engineering practitioners must leverage and integrate the knowledge that is appropriate to the project at hand from each theoretical foundation. The application of such theories, expressed as methods used to understand the problem and design the solution, will be specific to each system.

PPI principles for systems engineering and systems engineering management exploit, but don't specifically address, the scientific/theoretical foundations of systems engineering.

However, the value of developing both physical and logical models of the system is recognized:

- SE9: Except for simple solutions, develop logical solution descriptions (description of how the system solution is to meet requirements) as an aid to developing physical solution descriptions (description of how to build the system).

HYPOTHESIS 1: If a solution exists for a specific context, then there exists at least one ideal systems engineering solution for that specific context.

This hypothesis asserts the belief that an optimal (best balanced) solution design exists for any problem. The definition of optimal is based on "measures of goodness" derived from the system's mission and context including budget, schedule, decision timeframe (horizon), policy, law, and organizational culture. Viable solutions, if they exist for a particular problem, can be defined in terms of a mathematical function (aka objective function, value function or utility function).

PPI's Effectiveness Evaluation and Decision process identifies Measure of Effectiveness (MOEs) as a part of a stakeholder value model and uses these MOEs in the evaluation of solution alternatives. Effectiveness evaluation seeks to optimize overall effectiveness against MOEs while accounting for uncertainty/risk. The basis for this process is found in these principles:

- SE1: Capture and understand the requirements, *measures of effectiveness* and goals (the problem) before committing to the solution.
- SE4: Define system requirements, *measures of effectiveness*, goals and solutions having regard to the whole of the (remaining) life cycle of the system of interest.
- SE11: Decide between feasible solution alternatives based on evaluation of the *overall effectiveness* of each of these alternatives. Limit alternatives to be evaluated to those that have potential to be the most overall effective. Take risk and opportunity into consideration in the evaluation.
- SEM17: Select between (feasible) design alternatives based on the evaluation of *risk-adjusted expected effectiveness* to applicable stakeholders, i.e., on expected overall effectiveness. Note: "expected effectiveness" refers to effectiveness that incorporates uncertainty, reflecting risk and opportunity.

HYPOTHESIS 2: System complexity is greater than or equal to the ideal system complexity necessary to fulfill all system outputs.

This hypothesis asserts that, for any specific system context, the less complex solution is preferable.

PPI doesn't specifically address the role of system complexity in the form of principles, but teaches equivalent architectural design heuristics to highlight the benefits of and methods to achieve solution simplicity:

- Coupling (minimize)
- Cohesion (maximize)
- Connectivity (minimize)

HYPOTHESIS 3: Key stakeholders' preferences can be represented mathematically.

A large set of design decisions combine to create the system. These decisions require the consideration of preferences, beliefs, and alternatives. The relationships between preferences, beliefs, and alternatives may be expressed mathematically to inform the decision-making process.

PPI promotes a scalable, appropriately rigorous, mathematics-based method for making design decisions. A system value model is captured (ideally during system requirements analysis) to express stakeholder preferences. Models of alternatives and beliefs about their effectiveness (tempered by uncertainty/risk) are used to select the best-balanced solution.

- SE1: Capture and understand the requirements, measures of effectiveness and goals (the problem) before committing to the solution.
- SE11: Decide between feasible solution alternatives based on evaluation of the overall effectiveness of each of these alternatives. Limit alternatives to be evaluated to those that have potential to be the most overall effective. Take risk and opportunity into consideration in the evaluation.
- SEM17: Select between (feasible) design alternatives based on the evaluation of risk-adjusted expected effectiveness to applicable stakeholders, i.e., on expected overall effectiveness. Note: "expected effectiveness" refers to effectiveness that incorporates uncertainty, reflecting risk and opportunity.

PPI Systems Engineering Principles

The following table includes the full set of PPI's principles for systems engineering, with an initial mapping to INCOSE principles and hypotheses.

PPI SE Principle	INCOSE Principles/Hypotheses
SE1: Capture and understand the requirements, measures of effectiveness and goals (the problem) before committing to the solution.	P3, P4, P8, P10, H1, H3
SE2: Try to ensure that the requirements are consistent with what is predicted to be possible in solutions, at the time of required supply, i.e., are feasible.	P8, P10
SE3: Treat as goals desired characteristics that may not be feasible, but not at the expense of the requirements.	P8, P10
SE4: Define system requirements, measures of effectiveness, goals and solutions having regard to the whole of the (remaining) life cycle of the system of interest.	P8, P10, P11, H1
SE5: Maintain a distinction between the statement of the problem and the description of the solution to that problem, for the system of interest, and for each subsystem/component/system element of that system.	P2, P6
SE6: Baseline each statement of the problem (requirements, measures of effectiveness and goals set) and description of the solution to that problem (design). Control changes to requirements and design.	P7
SE7: Identify and develop descriptions of solutions alternatives (designs) that are both feasible (i.e., can meet requirements) and potentially are the most effective. Put aside from further consideration, as potential solutions, all other alternatives (unless the assessment of that potential solution changes).	P8, P9, P10

PPI SE Principle	INCOSE Principles/Hypotheses
SE8: Develop solution descriptions for enabling systems concurrently and in balance with the solution description for the system of interest.	P2, P11
SE9: Except for simple solutions, develop logical solution descriptions (description of how the system solution is to meet requirements) as an aid to developing physical solution descriptions (description of how to build the system).	P15
SE10: Be prepared to iterate in design to drive up overall effectiveness, but not at the expense of the requirements.	P5
SE11: Decide between feasible solution alternatives based on evaluation of the overall effectiveness of each of these alternatives. Limit alternatives to be evaluated to those that have potential to be the most overall effective. Take risk and opportunity into consideration in the evaluation.	P8, P9, P10, H1, H3
SE12: Subject to level of risk, independently verify work products (is the job being done right?)	P11
SE13: Subject to level of risk, validate work products from the perspective of the stakeholders whom the work products serve (is the right job being done?)	P11
SE14: The act of managing is needed to plan and implement the effective and efficient transformation of requirements and goals into solutions.	P12

PPI Systems Engineering Management Principles

The following table includes the full set of PPI's principles for systems engineering management, with an initial mapping to INCOSE principles and hypotheses.

PPI SE Principle	INCOSE Principles/Hypotheses
SEM1: The supplier purpose of SE management in commercial contexts is to maximize value to the enterprise by optimizing value to the customer.	P8
SEM2: The purpose of SE management for internal projects is to maximize value to the internal customer within the constraints that exist.	P8
SEM3: Establish a culture in which the application of systems engineering principles is embedded.	P14

PPI SE Principle	INCOSE Principles/Hypotheses
SEM4: Establish an objectively adequate problem definition before committing significant resources to design and development, subject to any need for evolutionary development (see below).	P3, P4
SEM5: Ensure that, for those performing requirements engineering functions, sound requirements engineering principles are understood and embraced.	P3, P4, P13
SEM6: Design a solution by dividing the big problem into a set of individually sufficiently well-defined smaller problems, i.e., by defining the required characteristics of each element of the solution (including both product {hardware and software, etc.} and process elements, as applicable).	P2, P6
SEM7: Apply design skills and technology knowledge in creating requirements.	P13
SEM8: Regard knowledge of relevant technologies, and the creativity and attitudes to apply that knowledge in a team environment, as indispensable ingredients of effective engineering.	P13
SEM9: Use sequential development (waterfall, grand design, “big bang”, etc.) for development, where requirements (etc.) are able to be well defined and stable, and solutions are relatively simple or well understood, i.e. the risks due to technology & complexity are low.	P1
SEM10: Use incremental development where requirements (etc.) can be well defined and stable, but solutions have risk due to technology and/or due to complexity.	P1, P5
SEM11: Use evolutionary development where requirements (etc.) are as well-defined as is possible in the circumstances, but remain inadequately defined from the point of view of the enterprise, or are subject to change that the enterprise needs to accommodate.	P1, P7
SEM12: Use a stage-based, stage gate, risk and opportunity-driven style of development as an overall strategy for development (sometimes referred to a Spiral development) where risk is significant (note that incremental and evolutionary are special cases of spiral).	P1, P5
SEM13: Apply the systems engineering process elements selectively within the context of sequential, incremental, evolutionary and/or the risk and opportunity-driven styles of development. Design the development process to match the nature of the problem, using the SE process elements as building blocks.	P1

PPI SE Principle	INCOSE Principles/Hypotheses
SEM14: Consider the use of agile development where usable increments of product are valuable and requirements may evolve, but not in ignorance of what is known or knowable about the problem at the start of development.	P1, P7
SEM15: Use the lean development approach (apply the lean enablers) to optimize value to the end customer by eliminating waste from the development process.	P1
SEM16: Use a concurrent engineering approach to simultaneously engineer the system of interest as well as all relevant enabling systems.	P2, P11
SEM17: Select between (feasible) design alternatives based on the evaluation of risk-adjusted expected effectiveness to applicable stakeholders, i.e., on expected overall effectiveness. Note: "expected effectiveness" refers to effectiveness that incorporates uncertainty, reflecting risk and opportunity.	P9, P10, H1, H3
SEM18: Manage the engineering - plan, organize, motivate, assess, control.	P12
SEM19: Recognize that the engineering system is a system like any other system. Engineer it as such.	P2, P11, P12, P14
SEM20: Use a product-oriented structure of products and related services, Project Breakdown Structure, also called Work Breakdown Structure (PBS/WBS), as a framework for definition, cost estimating, scheduling, risk and opportunity analysis, measurement, assignment of responsibility, team design and reporting.	P12
SEM21: Use empowered, product-oriented, multidisciplinary team structures for more complex engineering efforts.	P10, P12
SEM22: Choose to do things only in the rational expectation of producing a better result by doing so (on the balance of probabilities). Choose to NOT do things for EXACTLY the same reason.	P1
SEM23: General management, project management and engineering management principles are all generally applicable to systems engineering management.	P12

Conclusions

Not surprisingly, the mapping between INCOSE and PPI principles was found to represent many-to-many relationships. Lists of principles developed by different individuals in different time contexts with different definitions and for different purposes could not be expected to share a unified structure. However, the degree of overall positive alignment and lack of significant conflicts between these sets of principles are encouraging.

Only one INCOSE element, Hypothesis 2, lacked a PPI corollary. This is because PPI addresses architectural simplicity/complexity as design heuristics, not as top-level engineering principles.

Download your copy of Systems Engineering Principles from the INCOSE Store.

For another look at PPI's systems engineering principles, see the article on *A Fresh Look at Design Thinking in the Light of Proven Systems Engineering Principles* in PPI SyEN Edition #104 (September 2021).

INCOSE Copyright Notice

The Systems Engineering Principles document that has been referenced and oft-quoted within this article comes with the following copyright notice.

> ISBN 978-1-937076-08-5

References

[1] INCOSE 2022. *Systems Engineering Principles*. ISBN 978-1-937076-08-5. https://www.incose.org/seprinciples

[2] Project Performance International 2022. PPI Systems Engineering Principles. Workshop handout within PPI's Systems Engineering 5-Day Course.

[3] Project Performance International 2022. PPI Systems Engineering Management Principles. Workshop handout within PPI's Systems Engineering Management 5-Day Course.

[4] INCOSE 2021. *Systems Engineering Vision 2035*. https://www.incose.org/about-systems-engineering/se-vision-2035

About the Author

John Fitch is a Principal Consultant and Course Presenter for Project Performance International. John brings over four decades of systems engineering, engineering management, consulting, and training experience to the PPI team. In 2012, John was certified by INCOSE as an Expert Systems Engineering Professional (ESEP).

Within the field of systems engineering, John's career has focused on decision management, requirements management, risk management, systems design & architecture, product/technology road-mapping and innovation. In addition to defense/aerospace, John has guided initiatives in domains such as communications systems, software, energy, nanotechnology, medical devices, manufacturing systems, knowledge management and business process improvement.

SYSTEMS ENGINEERING RESOURCES

Useful artifacts to improve your SE effectiveness

New and Recommended PDMA kHUB Resources

kHUB PDMA Knowledge Hub

The Product Development Management Association (PDMA) continues to grow the content that is available through its Knowledge Hub (kHUB), a diverse repository of resources to assist the product development and innovation community. kHUB is the centralized digital content management and access platform for the extensive PDMA Body of Knowledge. kHUB is organized around key product development and innovation areas including:

Culture	Product Innovation Management
Market Research in Product Innovation	Product Innovation Process
Portfolio Management	Strategy
Product Design & Development Tools	Teams & Leadership

PDMA periodically highlights the most popular articles and podcasts based on kHUB user preferences.

Recommended open-access content from the fourth quarter of 2022 includes:

- How Effective Is Your Product Strategy at Delivering on Business Goals?
- Serial Innovators: How Individuals Create and Deliver Breakthrough Innovations in Mature Firms
- Four Steps to Product Management Excellence for B2B Companies
- The Critical Intersection of Diversity and Innovation
- Financial Outcome & Consumer Experience – The Dilemma of Every Product Manager
- Steve Jobs: A Product Developer's Perspective
- Find Pearls and Drive More Innovation in Your Portfolio
- Integrated Product Portfolio and Project Management: The Art of New Product Demand Planning
- Aligning Product Portfolios with Strategic Plans
- Scatterbrains: Teams Find Innovation by Thinking Differently
- New Product Innovation

Recommended member-only content includes:

- Save Agile - Stop Waterfall Planning**
- When Scrum is not Scrum**
- The Secret of Agile Motivation**
- Why the Business Needs Predictability from Agile**
- The Product Owner Is a Unicorn**
- The Mythical MMFS**
- Measuring Motivation**

*** Member login required*

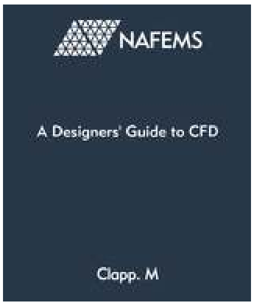
The kHUB team also recommends articles that have been published in the Wiley Journal of Product Innovation Management (JPIM) such as:

- Innovation or entrepreneurship: Which comes first? Exploring the implications for higher education***
- The human side of innovation management: Bridging the divide between the fields of innovation and organizational behavior***
- Design thinking as sensemaking: Developing a pragmatist theory of practice to (re)introduce sensibility***

***Access to JPIM content may be obtained by a PDMA membership or through a Wiley subscription.

Access to kHUB is free and open to the public. Create a guest account or join PDMA here.

Book: Designers' Guide to CFD



The *Designer' Guide to CFD*, authored by M. Clapp and published in 2019 by NAFEMS, parallels the concept behind the popular "A Designers' Guide to Simulation with Finite Element Analysis". In common with the structural simulation world, Computational Fluid Dynamics (CFD) software vendors have seen a growth of usage as they have linked closer to Mechanical Computer-Aided Design (MCAD) systems and done their utmost to make the process as easy as possible. This implies that CFD users are no longer the PhD qualified specialists that were most users as little as fifteen years ago.

These changes combined with the ever-increasing speed and affordability of computer processing technology has led to an influx of new users to CFD technology. These new users are probably more familiar with working with CAD geometry than the details of numerical simulation methods. This book is for these new users of CFD rather than existing CFD specialists.

Topics addressed in this book include:

- Where is Upfront CFD Applicable?
- Is My Simulation Fit For Purpose?
- The CFD Process
- Using Results to Improve Designs
- Project Reporting and Data Management
- Where to go for Help
- References

Learn more about or purchase the Designer' Guide to CFD here.
Visit the NAFEMS Resource Center.
Join NAFEMS.

NAFEMS Engineering Modeling, Analysis, and Simulation Blog

NAFEMS, the International Association for the Engineering Modelling, Analysis and Simulation community, maintains an active and informative blog that shares insights associated with this growing field.

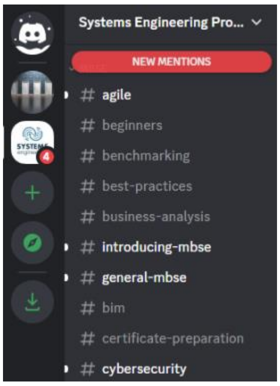
Posts published during 2022 include:

- How Much Can We Really Trust Artificial Intelligence?
- Developing Efficient Structural Concepts for the Future of Mobility

- How do you get ready for 2030? You've got to start now: How simulation is changing and what you need to do to keep up
- Industry 4.0, 5.0, and Beyond - Are You Ready for the Revolution?
- Uncertain Knowledge: A Challenge Problem
- Verification - How Much Should I Do? A Discussion with the NAFEMS SGMWG
- Define & Deliver Credible Results - Your Questions, Answered.
- Code Verification v Solution Verification - A Discussion with the NAFEMS SGMWG
- Credibility is Everything (Or How to Get the Most from Verification and Validation...)
- Simulation and Analysis in the Medical Device Industry - the Six Million Dollar Inspiration
- 9 Key Technical Takeaways from the NAFEMS World Congress 2021

Check out and subscribe to the NAFEMS blog here.

Systems Engineering Professionals Community at Discord



A Systems Engineering Professionals server (a topic-based invitation-only community/channel) has been launched on Discord, a free communications and social networking/sharing platform that runs in various browsers with apps for common devices. Originally focused on game communities and game developers, Discord is now home to over 100 million users who share content of interest over text, voice or video.

Current subchannels (an ever-growing list of topics) in the Systems Engineering Professionals server include:

- MBSE (agile, beginners, best-practices, business-analysis, frameworks, ...)
- Tooling (cameo, capella, enterprise-architect, papyrus, rhapsody, innoslate, ...)
- Literature (knowledge-base and various books)
- Industry (aerospace, government, space, industrial, infrastructure, ...)
- Methodology (oosem, arcadia, magicgrid, sysmod, acre, opm, ...)
- Jobs (hiring, looking)

Background:
Zsolt Sándor provides the historical context for the Systems Engineering Professionals Discord server:

Hello, my name is Zsolt Sándor and I am from Budapest, Hungary. I have a Master's degree in computer engineering with a specialization in fault tolerant systems. I have worked as a software engineer for almost two decades and have been doing systems engineering for the past three years. Interestingly, it happened by accident: at my current company, we had an external modeling team that used SysML and a variation of OOSem to support us in designing our new green field distributed, microservice-based system. After the team left the company, we inherited their work, and this is how my journey started. We began gathering as much knowledge as we could, mostly through books and internet conversations on social media.

One day, I was busily asking and answering questions on Reddit when Denim Pinto, who works for PacktPub, reached out to me and asked if we could build a community with better interaction for systems engineers. He suggested starting a Discord server for systems engineering professionals, and so we did. We started with a small number of people, less than ten, but even in the first week, we had a couple of video calls introducing ourselves to each other. Then we started to grow slowly. When we first reached a hundred, we knew that this might actually work in the long term. More and more people joined the server and started interacting with each other. Some fellow members of the community even made video presentations.

The server now has more than 550 members with steady growth. Although the number of members is an *important part of the equation, the most important part for me is that we have created a community of like-minded systems engineers who help and support each other. We connect people who have job offers with those who are looking for a job. We help authors by providing reviews for their books. We are trying to bridge the gap between the academic world and the industry by bringing those people closer so they can learn from each other. We help content creators to share their videos and articles with the community so we can increase the overall knowledge and skill set. We support the next generation of systems engineers in their first steps by providing them with coaching and materials.*

My personal goal is to grow the systems engineering community by providing an opportunity for fellow colleagues to meet, get to know each other, build personal and professional relationships, and grow together. For this, the server is a great tool.

PPI SyEN readers are encouraged to check out this growing community. Use the invitation link below to join System Engineering Professionals.

https://discord.gg/YwWhvZubCb

NAFEMS E-Learning Courses

E-Learning Courses

NAFEMS offers a diverse range of code-independent, in-depth online training courses on engineering analysis & simulation. Since 2009, over 10,000 individuals from around the globe have been trained, from all ability levels across every industry.

The initial course offerings for 2023 include:

- Simulation of Lubricated Contacts
- Fundamentals of Multibody Dynamics Simulation
- Understanding Solid Mechanics: Applied Stress Analysis
- How to Implement a Modelling & Simulation Strategy
- Metals Material Modelling: Creep
- Next Steps with Multibody Dynamics Simulation
- How to Effectively Communicate Innovative Ideas
- Successful Explicit Dynamic Analysis in 10 Steps
- Metals Material Modelling: Welding Simulation and Residual Stresses
- Practical Understanding of Systems Modelling and Simulation
- Basic Electromagnetic FEA

View the current course listing.
Join the NAFEMS E-Learning Wait List to be notified when a future course of interest will be offered.

FINAL THOUGHTS FROM SYENNA

Dear Reader,

Should you be visiting friends and family over the New Year, I suggest you keep away from the traffic island depicted below. Let me imagine a scenario…

- you have never been here before and your Voice of Doom Satnav insists you take the first exit;
- it is dark and wet;
- if you spend more than 10 seconds trying to decode the sign you will hit a bicycle, e-scooter, pedestrian, or taxi;
- being a 24-hour clock person, you spend 5 seconds trying to process the time slot information;
- then another 5 seconds trying to find the clock on the car infotainment system (which moves the clock depending on what apps you have running) [Ed: the purpose of a private vehicle is to provide a mobile structure onto which you can mount your social media experience];
- then another 5 seconds figuring out whether or not it's Sunday (speaking for myself here)
- now you have to work out whether or not you're allowed to take the 1st exit
  - If I'm driving a car or motorbike I can't do that unless I'm also a local bus;
  - What if I'm driving a van, motorhome, bicycle, or e-scooter and I'm not a local bus?
- by which time you have done one of the following:
  - crashed;
  - taken the 2nd exit (which you didn't want);
  - taken the 1st exit and been snapped by the carefully-placed automatic traffic camera;
  - done a U-turn round the island and gone back home.

<u>Conclusions</u>

1) the purpose of the road sign, which is to earn the local council £1M in traffic penalties, has reportedly been achieved several times over;
2) it is not necessarily the case that a sequential life cycle model is a good choice for a road sign acquisition project *[Ed: a sequential approach may be the optimum if the problem and solution are both well-understood]*