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Navigating Competing Visions: Human Thinking in the Age of Digital Engineering and AI

FEATURE ARTICLES

The Challenges of Establishing an Authoritative Source of Truth in a Data-Driven Engineering Ecosystem

Impressions From INCOSE IS2025 in Ottawa

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WELCOME

Dear Readers,

Welcome to the August edition of *PPI Systems Engineering Newsjournal (SyEN)*.

This issue captures both the continuity and the change that define our profession. On the one hand, we see decades-long initiatives coming to fruition—most notably, the final adoption of SysML v2 by the OMG, a milestone seven years in the making, which sets the stage for more precise and interoperable modeling across disciplines. On the other hand, we see rapid shifts—AI reshaping not only tools and methods but also how we think about trust, governance, and the very definition of an authoritative source of truth.

Our feature article by Dr. Warren Vaneman tackles exactly that: the challenges of establishing an *Authoritative Source of Truth* in today's data-driven engineering ecosystems. Alongside it, our report from INCOSE IS2025 in Ottawa reflects a community grappling with both excitement and skepticism around AI, SysML v2, and competing MBSE paradigms.

In our *Resources* section, you'll find updates on tools, standards, and new practices, while the *News* section highlights organizational shifts such as the EDM Council's acquisition of OMG, the expansion of digital twin capabilities, and new NIST guidance on zero-trust architectures.

And, as always, we close with Syenna's *Final Thoughts*. This time, Syenna takes us from galaxies far, far away to Hollywood boardrooms, with a witty reminder that even billion-dollar franchises can stumble when they forget the basics: know your stakeholders, validate their needs, and resist the temptation to dictate what the audience—or the user—*should* want.
We hope this issue gives you both insight and inspiration as you continue your own practice of systems engineering.

Francois

Managing Editor (on behalf of the PPI SyEN Team)

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

> *If you don't know where you're going, you're unlikely to end up there.*
>
> **Forrest Gump**

PPI Systems Engineering Newsjournal (PPI SyEN) seeks:

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

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

SYSTEMS ENGINEERING NEWS

Recent events and updates in the field of systems engineering

SysML v2 Final Adoption

On 22 July 2025, the Object Management Group (OMG) announced the final approval of the Systems Modeling Language™ Version 2. This approval includes the Systems Modeling Language (SysML) version 2.0 specification along with the Kernel Modeling Language (KerML) specification version 1.0 (that provides a semantic and syntactic foundation for SysML v2) and the Systems Modeling Application Programming Interface (API) and Services specification version 1.0 that enables SysML v2 models to interoperate with other models and tools. This adoption is the result of a seven-year effort with extensive contributions from numerous OMG members.

Key benefits and features of SysML v2 include:

- improved precision, expressiveness, consistency, usability, interoperability, and extensibility over SysML v1
- modeling of increasingly complex systems as part of the evolving practice of model-based systems engineering
- complementary textual and graphical representations of the underlying model
- standard API and associated set of services to improve model and tool interoperability

Learn more here.
Access reference implementation materials from the OMG® Systems Modeling Community.

EDM Council Acquires Object Management Group (OMG)

The Object Management Group (OMG) has announced that a definitive agreement has been signed with the EDM Council®, the global association for data management, that will result in OMG's acquisition by 4Q2025. The combined non-profit association, renamed the EDM Association, will bring together more than 700 corporate and public-sector member organizations, eight regional hubs, and a combined 50-year portfolio of internationally adopted standards and technology.

The EDM Association will provide multiple advantages to its members, including:

- Increased industry reach, representing over 30,000 professionals worldwide
- A single, authoritative standards partner and community of experts
- Stronger connections between data management, standards, and innovation that make data truly portable, interoperable, and AI-ready
- A single, integrated organization with a comprehensive end-to-end data capability and roadmap

- Rapid adoption of emerging specifications, with potential onward pathways to ISO standardization
- Increased professional development opportunities

Read the full OMG press release.

Digital Twin Testbed – Expanded Capabilities

The Digital Twin Consortium (DTC), which announced the Digital Twin Testbed Initiative in early 2025, has now officially launched this member-driven platform for the development, testing, and validation of digital twin systems and enabling technologies. Early participants in this initiative have created an impressive portfolio of capabilities thus far, including:

- A Blueprint for Property and Asset Risk Management: Transforming Continuous Property and Asset Management with AI and Compliance-Ready Twins
- Automated Negotiation with Digital Twins and MAGs: Solving Cross-Boundary Coordination Through Intelligent Digital Negotiation
- Cognitive Network Orchestration: Proving Digital Twins Can Talk Across Domains Using Standards
- Digital Engineering for the Next Generation: Creating "Born Qualified" Assets Through AI, AR/VR, and Hybrid Manufacturing
- Digital Twins for Metal 3D Printing and Optimization: Advancing Real-Time, Closed-Loop Additive Manufacturing
- Generative AI for Healthcare Digital Twins: Secure Graph-Based AI Agents for Smarter Patient Data Management
- Sustainable Energy Digital Twin for Operational Management: Accelerating Sustainable Energy Operations with AI-Ready Digital Twins
- Virtual Twins for Smart Factory Innovation: Driving efficiency and agility with end-to-end line management

DTC members may submit a Testbed Initiative interest form to join the Testbed Program.

INCOSE Q2 2025 Highlights

INCOSE published its Q2 2025 Members Newsletter in June. Although much of this news may be superseded by the events at the International Symposium in July, here is a small sample of topics of interest in this 101-page publication.

Some interesting news:

- INCOSE membership grew by 15% in 2024
- More than 570 members have used the INCOSE Systems Engineering Laboratory (SE Lab) in the past two years

Noteworthy publications include:

- 2024 Annual Report
- Systems Engineering Competency Framework, 2nd Edition
- SEBOK v2.12

Chapters highlighted the following accomplishments:

- The long-dormant Emerald Coast chapter has been revived, serving Northwest Florida, USA.
- Members from the Canada chapter played a significant role in the IEEE SYSCON 2025 event in Montreal in April while continuing preparations for hosting IS2025.
- The ChicagoLand chapter held a seminar in May on Cybersecurity and the Age of AI: A Systems Thinking Perspective.
- INCOSE UK will transition to The Institute for Systems Engineering (IfSE) this summer.

Working Groups and Initiatives report that:

- The INCOSE Healthcare WG conducted the 10th Annual Systems Engineering in Healthcare Conference, with 190 attendees.
- The Configuration Management WG continues collaboration with the Product Line Engineering (PLE) WG in review of the new ISO/IEC 26581 standard.
- The Decision Analysis WG released version 1.0 of the Decision Analysis Data Model (DADM).
- Cohort 11 of the Technical Leadership Institute (TLI) was launched in June with 22 new members beginning this learning journey.

NAFEMS Technical Working Group Update

NAFEMS, the International Association for the Engineering Modelling, Analysis and Simulation community, has formed several Technical Working Groups (TWGs) that focus on specific areas of engineering simulation. In May 2025, NAFEMS published a 19-page summary of the recent activities of the TWGs, including:

- Composites (CWG)
- Computational Electromagnetics Working Group (CEMWG)
- Computational Fluid Dynamics Working Group (CFDWG)
- Computational Structural Mechanics Working Group (CSMWG)
- Education and Training Working Group (ETWG)
- Engineering Data Science Working Group (EDSWG)
- Geotechnical Working Group (GWG)
- High-Performance Computing Working Group (HPCWG)
- Impact, Shock and Crash Working Group (ISCWG)
- Medical Devices and Life Sciences Working Group (MDLSWG)
- Manufacturing Process Simulation Working Group (MANWG)
- Multibody Dynamics Working Group (MBDWG)
- Multiphysics Working Group (MPWG)
- Optimisation Working Group (OWG)
- Particle Methods Working Group (PMWG)
- Simulation Data Management Working Group (SDMWG)
- Simulation Governance & Management Working Group (SGMWG)
- Stochastics Working Group (SWG)

- Systems Modelling and Simulation Working Group (SMSWG)
- Upfront Simulation Working Group (UFSWG)

Non-members may create a guest NAFEMS account to access the Technical Group Update and other open-access publications.

Join NAFEMS to participate in a TWG.

Modelica Association News

Modelica is a freely available, equation-based, object-oriented language for convenient and efficient modeling of complex, multi-domain cyber-physical systems described by ordinary differential, difference, and algebraic equations. The Modelica Association is a non-profit organization that develops coordinated, open-access standards and open-source software in the area of cyber-physical systems. Highlights from the Association's (July 2025) newsletter are found below.

Board Highlights

A report from Dirk Zimmer, Modelica Association Chair, highlights his recent trip to China to investigate the widespread use of Modelica in that nation. He explores the upside of this explosive community growth, as well as the challenges of achieving tighter integration with the rest of the Association's global membership.

Conferences and User Meetings

The Association looks forward to its primary annual event, the 16th International Modelica & FMI Conference, which will take place in Lucerne, Switzerland, on 8-10 September. The preliminary agenda includes four tracks:

- Use of models in AI and the use of AI in models
- Energy systems
- FMI and related (layered) standards (including MBSE workflow integration)
- General Modelica, e.g., equation-based modeling and its tooling

Fifteen tutorials will provide educational opportunities for members of the community. A panel discussion titled *Open Standards vs. Open source, Collaboration or Conflict?* rounds out the program.

Functional Mock-up Interface (FMI) News

FMI-LS-BUS v1.0.0 has been released, defining how to realize the simulation of network communication of virtual Electronic Control Units (ECUs) with FMI 3.0 means.

The FMI project celebrates the milestone of 250 tools supporting the Functional Mock-up Interface (FMI) standard, as shown on the FMI tools page.

FMI project members will deliver several tutorials at the upcoming Modelica and FMI Conference, including:

- FMI Beginners tutorial
- eFMI® tutorial

- FMI Import & Export using C

Modelica Vendor News

Modiator (Modelica Instant Simulator) v.0.1.0, a browser-enabled simulator for a subset of Modelica, will be released at the upcoming conference and will also be the subject of a conference tutorial.

orchideo | easySSP v1.4.2 has been released with support for:

- Hierarchical parameter handling
- Import/export of components as System Structure Description (SSD) files
- Import/export of classifications in Simulation Resource Metadata (SRMD) format

XRG Simulation will offer a tutorial, *Using SMArtInt+ - Machine-learning and easy integration of artificial intelligence in Modelica*, and two talks at the conference demonstrating AI integration into Modelica.

Wolfram will host the Virtual Technology Conference 2025 on 5-7 November. The features planned for Wolfram System Modeler 14.3 have been announced.

Siemens Digital Industries Software has released Simcenter Amesim 2504, featuring accelerated simulations and improved model validation tools.

OpenModelica 1.25.1 has been released, with a focus on bug fixes and stability improvements.

Modelon will present a conference tutorial, *Beyond Simulation – Building Workflows and Web Applications with Modelica and Python*. Modelon is also launching a new help center and community site and taking waitlist registrations here.

Model Based Innovation LLC is leveraging Modelon Impact as its service delivery platform and continues to expand its service and training offerings.

Dassault Systèmes has made available the recording of a 12 June webinar on Sustainable Energy Systems.

View details of these and other announcements in the latest Modelica Association newsletter.

Synopsis Acquires Ansys

Ansys, an MBSE and multi-physics simulation leader through software tools such as ModelCenter, Discovery, SCADE Architect, and Twin Builder, has announced its acquisition by Synopsis, an industry leader in silicon design. The combined firm intends to maximize the capabilities of product R&D teams, enabling them to rapidly innovate AI-powered products.

Sassine Ghazi, Synopsis President and CEO, elaborates on this strategy:

"The increasing complexity of developing intelligent systems demands design solutions with a deeper integration of electronics and physics, enhanced by AI. With Ansys's leading system simulation and analysis solutions now part of Synopsys, we can maximize the capabilities of engineering teams broadly, igniting

their innovation from silicon to systems"

Read the full Synopsys press release and associated FAQs.

Ansys Government Initiatives (AGI) remains a wholly owned U.S. subsidiary and qualified non-traditional U.S. defense contractor that will continue to provide simulation products and services to the U.S. defense industrial base.

Learn more here.

Lifecycle Modeling Language (LML) 2.0 Released

The Lifecycle Modeling Organization (LMO) announced the release of the Lifecycle Modeling Language (LML) Specification (Version 2.0) in April 2025. LML 2.0 refines the LML 1.4 ontology and enhances its usability across increasingly complex, distributed systems, consistent with the standard's charter:

A standard Lifecycle Modeling Language (LML) will provide organizations with a structured and behavioral language that will provide a simple way to understand and communicate cost, schedule, and performance design information to all stakeholders in a standard manner. The combination of a simple structure with appropriate graphical visualizations for every entity class will facilitate the understanding of the design for all stakeholders throughout the product lifecycle (concept through disposal). This language will reduce the cost of design and enable more rapid product development to better match information technology and other technical product development timelines.

Key improvements in LML 2.0 include:

- Enhanced ontology structure
- Improved visualization tools
- Stronger lifecycle integration
- Governance and extensibility
- Better support for Digital Engineering

The LML standard comes in two formats:

- PDF
- Digital (requested at info@lifecyclemodeling.org)

View the release announcement on LinkedIn.

NIST Zero Trust Architectures

In June 2025, the U.S. National Institute of Standards and Technology (NIST), through its National Cybersecurity Center of Excellence, published new guidance on how to strengthen cybersecurity through the use of a Zero Trust Architecture (ZTA). Key concepts behind the movement toward ZTA's include:

- The traditional approach to cybersecurity, built around the idea of solely securing a perimeter, has given way to the zero-trust approach of continuously evaluating and verifying requests for access.
- Zero-trust architectures can help organizations protect far-flung digital resources from cyberattacks, but building and implementing the right architectures can be a complex undertaking.

The new NIST guidance document, *Implementing a Zero Trust Architecture*, NIST Special Publication 1800-35, offers 19 example zero trust architectures using off-the-shelf commercial technologies, giving organizations valuable starting points for building their own architectures.
The 54-page guide, available in PDF format, includes the following topics:

- Project Overview
- Architecture and Builds
- Build Implementation Instructions
- General Findings
- Functional Demonstrations
- Risks and Compliance Management
- Zero Trust Journey Takeaways

An online version of the ZTA document is also available here.

The guide builds on the conceptual foundation laid by NIST Special Publication 800-207, *Zero Trust Architecture* (August 2020), which summarizes ZTA basics, logical components, deployment scenarios, threats, migration strategies, and gaps.

View the NIST news release here.
Download a 2-page fact sheet on the ZTA Guide.

Systems Engineering Research Center (SERC) Updates

The June 2025 update from the Systems Engineering Research Center (SERC) highlights this organization's research-driven contributions to systems engineering practices. Project updates from SERC's partner agency, the Acquisition Innovation Research Center (AIRC), are also published in this edition. This edition highlights the restructured SERC website in addition to recent research results.

Research projects highlighted in this update include:

- AI-based Defense Pricing, Contracting, and Acquisition Policy (DPCAP) FAR/DFARS Change Support Tool (Stevens)
- AI-based Defense Pricing, Contracting, and Acquisition Policy (DPCAP) FAR/DFARS Change Support Tool (Virginia Tech)
- Designing a Functional Information Retrieval System for Dynamic Organizational Use
- Enabling Data Management of Intellectual Property License Rights for the Department of Defense
- Identifying Novel Ways to Incentivize Industry in Defense Acquisition

SERC has updated its website to group research publications into four searchable focus areas:

Digital and Data-Driven Systems
We are working to advance the digital and data-driven methods and tools used to store, access, analyze, and visualize evolving systems' data and models across engineering, acquisition, program management, product management, test & evaluation, sustainment, and other functions. SERC conducts research on data-driven ecosystems, ontologies and linked data, trade space analysis, data/model management, human and machine collaboration, AI and machine learning, and automation – all to improve the speed, trust, scale, and transparency of engineered systems.

Trusted Systems
Our research intersects with technical and social science disciplines, going beyond the capabilities of a system to the qualities affecting its reliability, availability, dependability, integrity, safety, security, and resilience – all qualities of trust. While trustworthiness is a property of the system, trust is a property of the relationship between a user and the system.

Using model-based methods, SERC researchers are making systems more resilient to cyber-attacks and advancing system design and test methods for trust and resilience of AI-enabled systems.

Enterprises and System-of-Systems
Our research is at the forefront of system complexity and scale. Today, systems are being designed for change, combining durable and attritable systems, and are not constrained in or on a physical or virtual platform. Capability analysis is increasingly at the mission, system-of-systems (SoS), and enterprise levels. Future systems will be more complex, nonlinear, and non-stationary in their behavior, and we can no longer analyze or design them effectively via traditional SE decomposition. SERC is using AI and data visualization to advance enterprise portfolio analysis, mission engineering, testbeds for future wireless systems, and management of megaprojects.

Human Capital Development
From our very first research task, which resulted in the Systems Engineering Body of Knowledge (SEBoK), SERC research continues to contribute directly to human capital development. SERC helps the DoD develop its current and future workforce with advanced technical and employability skills.

Featured projects include the Helix assessment to understand what makes systems engineers effective, a digital engineering simulator for Defense Acquisition University, the Capstone Marketplace, and more.

A separate web page now focuses on Resources and Partners, including:

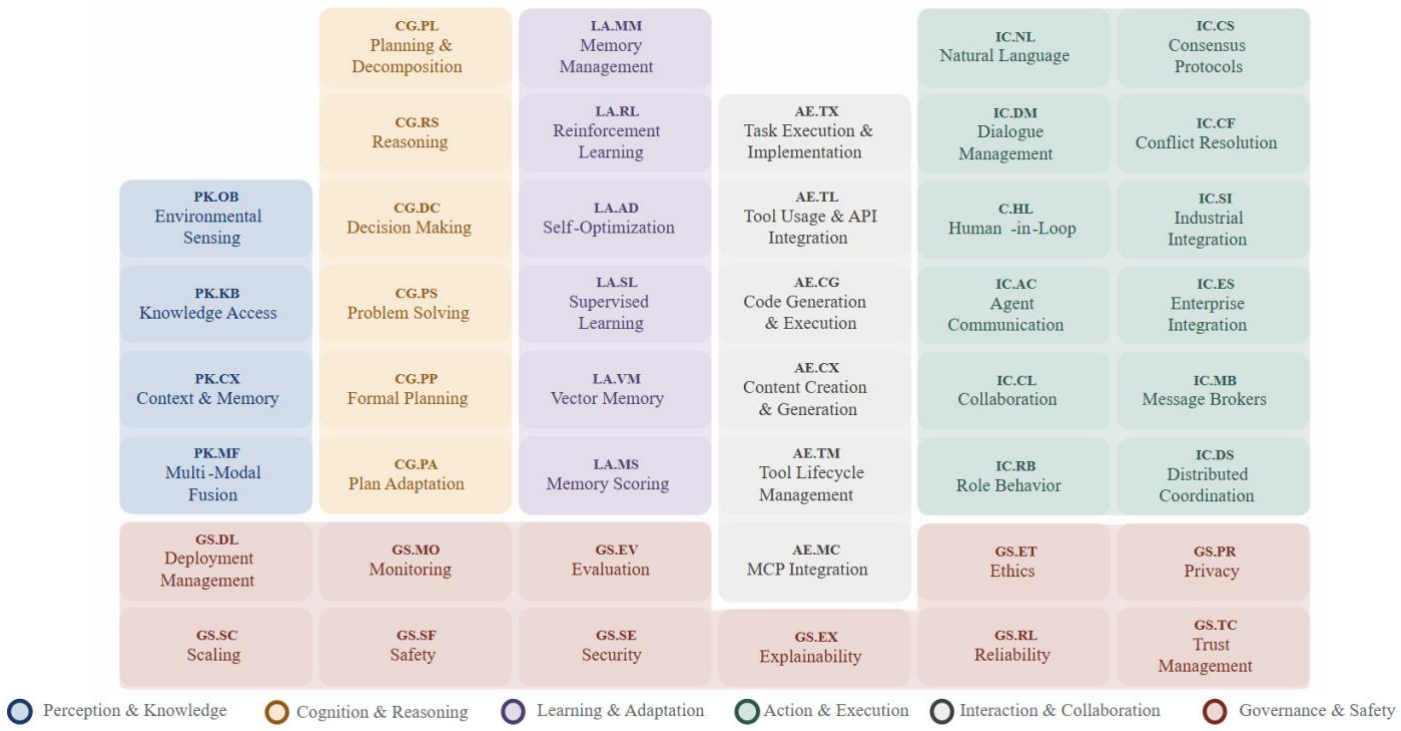
- Systems Engineering Body of Knowledge (SEBoK)
- Digital Engineering Body of Knowledge (DEBoK)
- SERC Talks Webinars
- Systems Engineering for the Digital Age: Practitioner Perspectives
- Worldwide Directory of Systems and Industrial Engineering Programs
- SERC Network Analysis & Visualization
- SystemiTool

Biographies of SERC personnel and leadership may be found in the People section of the website.

Access the latest SERC news here.
Follow SERC on LinkedIn.

DTC Launches AI Agent Capabilities Periodic Table (AIA CPT) Framework

The Digital Twin Consortium (DTC) has launched an AI-powered toolkit that helps organizations build intelligent AI agents from concept to execution across any industry. The AI Agent Capabilities Periodic Table (AIA CPT) framework is a comprehensive toolkit with 45 distinct AI capabilities organized into six core categories.



The framework works seamlessly with existing Digital Twin systems, enabling organizations to create "intelligent digital twins" that can adapt and act autonomously. It transforms AI agent development from complex guesswork into systematic execution, helping any organization deploy intelligent, adaptive AI systems faster and more effectively.

The AIA CPT Toolkit includes:

- A visual model of 45 capabilities across six core categories
- A comprehensive user manual for internal alignment and planning
- YAML implementation examples for technical teams
- A structured Excel matrix for gap analysis and roadmap development
- Access to a public GitHub repository for community input and extensions

Download the AIA CPT toolkit.

Systems Engineering Tools Database (SETDB) Updates

The Systems Engineering Tools Database (SETDB), developed by PPI in partnership with INCOSE, provides a virtual platform for engineering tool vendors to communicate their latest offerings.

Recent SETDB updates, including both new tools and updates to existing tools, include:

Vendor: Alignd Labs

- Reqchoir: A cloud-based solution for capturing and managing requirements, issues with requirements, and managing changes to the requirements. It also includes document management, a workflow engine, customizable reports, a wide range of import and export formats, and a SOAP API for integration.

Vendor: Altair Engineering Inc.

- AI Studio: The data science tool anyone can use to design and prototype highly explainable AI and machine learning models. It offers a visual drag-and-drop workflow designer, automated machine learning tools, support for generative AI, and interactive data prep capabilities.

Vendor: Altreonic

- GoedelWorks: An internet-based portal for safety engineering and systems engineering projects. It is intended for use by global and distributed teams to facilitate how people work together to build systems and products, making project delivery more collaborative, productive, and transparent.

Vendor: Ansys Inc.

- Digital Safety Manager: Recognizes and reflects the way safety teams work every day, not only internally but with their suppliers, assessors, and reviewers. It is well integrated with tools for safety engineering as well as PLM and project planning tools for many different industry domains.
- Discovery: The first 3D simulation-driven design tool combining instant physics simulation, high-fidelity simulation, and interactive geometry modeling in a single easy-to-use experience. Provides structural,and thermal fluid analysis, geometry modeling, and modal analysis.
- ModelCenter: A vendor-neutral software platform for creating and automating multi-tool workflows, optimizing product designs, and enabling Model-Based Systems Engineering (MBSE).
- ModelCenter® Explore: Drives innovation and improves product quality by enabling users to thoroughly explore and understand the design space, make better decisions, and find optimal solutions. Users can search, analyze, change variables, visualize results, and change impact to find optimum solutions.
- SCADE Architect: Specifically developed for system engineers. It provides full support of industrial systems engineering processes, such as ARP 4754A, ISO 26262, and EN 50126. SCADE Architect features functional and architectural system modeling and verification in a SysML-based environment.
- SCADE Display: A specialized tool for modeling human-machine interfaces. SCADE Display facilitates embedded graphics, display, and HMI development, and certified code generation for safety-critical displays.

- SCADE Lifecycle: Enhances the functionalities of Ansys SCADE® tools with add-on modules that bridge SCADE solutions and Requirement Management tools or PLM/ALM (Product Lifecycle Management/ Application Lifecycle Management) tools.
- SCADE One Essential: Develop safe and reliable embedded software, reduce development time and costs, and secure your certification journey.
- SCADE Test: A complete model-based testing environment for requirements validation and verification (V&V), as well as test case creation and management. You can automate test case execution both on the host and on the target, measure coverage, and manage test results for any SCADE application.
- SCADE Vision: Automates the identification of potential vulnerabilities in autonomous vehicle (AV) perception systems, reducing the costs of testing and safety activities for AI-based embedded perception software.
- SpaceClaim: A modeling solution for engineers who want access to 3D answers but don't have the time or inclination to learn complex traditional CAD systems. It provides tools to accelerate geometry preparation and get to simulation sooner while eliminating delays between design teams.
- Systems Tool Kit (STK): Enables you to model complex systems with realistic & time-dynamic three-dimensional simulation. Simulate the entire system-of-systems, at any location & at any time, & across multiple domains, to gain a clear understanding of mission performance.
- Twin Builder: A multi-technology platform that allows engineers to create simulation-based digital twins–digital representations of assets with real-world or virtual sensor inputs.
- Systems Architecture Modeler (SAM): A cloud native general-purpose system architecture modeling tool based on SysML v2 (in development).

Vendor: avolution

- ABACUS: A cloud-based collaborative enterprise architecture tool that connects IT and business strategies; supports over 100 Enterprise Architecture Frameworks; several standard modeling languages; and standards like the ISO/IEC 42010 standard for system and architecture descriptions.

Vendor: Balsamiq Studios, LLC

- Balsamiq Wireframes: A UI wireframing tool intended for use by UX designers to help programmers and designers think and communicate about the structure of the software or website you're building. It is similar to using a sketch pad or whiteboard to build a prototype of your software.

Vendor: Broadcom Inc.

- ValueOps®: The industry's only complete solution for end-to-end value stream management - built to drive digital transformation by bringing visibility, alignment, and efficiency to the value stream lifecycle.
- Rally Software: An enterprise-class platform for scaling agile development practices. Users can plan, prioritize, track, and continuously improve business processes to give their business predictability and adaptability.

Vendor: BusinessOptix

- Process Transformation Platform: A process transformation platform intended for use by organizations to improve their business processes in order to improve their customer interactions, the way their employees work, and the results their business achieves.

Vendor: CACI Ltd.

- MooD Software: A business modelling tool intended for systems engineers, solution designers, and architects, and commercial and business decision-makers to create accessible visualisations and process maps that relate complex technology systems to the business outcomes they support.

Vendor: Change Vision, Inc.

- Astah System Safety: A modeling tool for safety-critical systems to support system architecture modeling, system safety assessment, and analysis.
- SysMLv2 Editor for Visual Studio Code: SysMLv2 Editor for Visual Studio Code is a lightweight extension developed by Change Vision, Inc., designed for engineers working with SysML v2. It enables fast, syntax-aware model editing, with key productivity features such as real-time validation, symbol navigation, and diagram visualization.

Vendor: Dakota Software Corporation

- ProActivity® Suite: A suite of Environmental Health and Safety (EHS) tools intended for use by companies to plan, track, audit, report on incidents, and measure progress toward corporate sustainability goals on their EHS compliance programs.
- Insights: A flexible Business Intelligence (BI) platform designed for data-driven organizations. It helps EHS leaders unlock the power of their data and share actionable intelligence with stakeholders across their organization by drawing data from the Proactivity Suite.
- Profiler: Centralizes EHS Regulatory Registers, streamlines permit management, and automates compliance tracking.
- Scout: Simplifies tracking of injuries, near misses, environmental incidents, and other events, and helps to proactively improve Using interactive dashboards, EHS leaders can analyze data on EHS performance and regulatory compliance to identify trends and correlations across their locations.
- Tracer: Consolidates Action Items originating from action plans, audit findings, and incidents and issues to provide real-time visibility throughout the organization.
- Auditor: Helps organizations stay in control of complex regulatory requirements by showing just the information that pertains to their facilities while still providing comprehensive audit protocols.

Vendor: Dalus

- Dalus: A modern Model-Based Systems engineering software that enables engineering teams to model system architecture, simulate performance, and manage requirements on an AI-driven collaborative platform.

Vendor: Denso Create Inc.

- Next Design: A new design tool for embedded systems and software development. By customizing the "metamodel" that defines the structure of design information and the "view definition" that visualizes it, the tool can be tailored to fit specific development processes.

Vendor: Diakronos Solutions Inc.

EpochShift: A Multi-Attribute Tradespace Exploration and Epoch Era Analysis software providing a systems engineering toolbox for Interactive Data Visualization & Exploration, stakeholder modeling, and uncertainty analysis of the outputs of evaluative models for

engineering, research, and business applications.

Vendor: Digital.ai Software Inc.

- TeamForge®: A traditional ALM solution intended for use by cross-functional teams to collaborate effectively and share expertise, best practices, and code. Provides end-to-end traceability across multiple tools, distributed development teams, and diverse processes and version control.

Vendor: Digité, Inc.

- kAIron: A web-based microservices-driven suite intended for use by those who work with AI-assistants to help them train contextual AI assistants by giving them a no-coding web interface to adapt, train, test, and maintain such assistants.
- RISHI-XAI: Digite's next-generation XAI (eXplainable AI) enabled Enterprise Project Intelligence product is intended for use by CXOs, Delivery Heads, Project Managers, and other decision-makers to predict what is likely to happen with current projects. It combines Machine Learning and expandable AI.

Vendor: DNV

- Battery AI: An artificial intelligence-driven battery analytics platform that acts as a repository for Battery Scorecard testing data and forecasts the lifetime of batteries under custom duty cycles. Battery AI offers a platform to compare different technologies and evaluate the expected lifetimes.

Vendor: ease solutions Pte Ltd

- Requirements Management for Jira: A plugin for Jira Software intended for use by agile teams to establish custom requirements hierarchies, manage & trace requirements to support revision tracking and reuse.
- Test Management for Jira: A plugin for Jira Software intended for use by agile teams to create test plans, plan your tests, execute your tests, generate execution reports, and connect your development platform to your test tools.

Vendor: Eccam s.r.o.

- ReqVIEW: A requirements management tool intended for use by development teams to import documents, elaborate on requirements, risks, and tests while keeping track of project changes, and finally, export specifications or traceability reports.

Vendor: Excel Software

- WinA&D: A software design tool for the Windows platform for use by software developers for Requirements Management, UML, SASD, BPMN, Flowcharts, PERT Charts, System Models, Data Models, Screen Models, and Code Generation.
- MacA&D: A software design tool for the Macintosh platform for use by software developers for Requirements Management, UML, SASD, BPMN, Flowcharts, PERT Charts, System Models, Data Models, Screen Models, and Code Generation.

Vendor: HaskoningDHV

- Twinn Witness: Gives you the power to validate decisions in a risk-free environment by using virtual models of your existing and planned facilities and operations. User-friendly, flexible, and powerful, Witness gives you detailed insights into CapEx, continuous, and operational improvements.

Vendor: IDEACore LLC

- Catalyst Suite: An Integrated Suite of tools including QFD Designer (Voice of the Customer), TRIZContrasolve (inventive problem solving), and WEBmine (discovery tool).
- TRIZContrasolve: Automates the TRIZ Contradictions matrix, making it easy for you to find the right principles to help your designs overcome technical logjams. TRIZContrasolve uses an extensible XML dataset to export your data to other tools, and QFDDesigner integrates with TRIZContrasolve.
- QFD Designer: The world's first Windows application software for QFD, regarded by many to be the simplest to learn and use. But the simplicity is not at the expense of power; it is very robust. You can build all the charts and reports you need to practice QFD successfully in one package.

Vendor: Inflectra Corporation

- SpiraPlan: An enterprise agile program management tool intended for enterprises to manage projects and programs. Features a large selection of plug-ins and add-ons to allow seamless integrations with a variety of other systems.
- SpiraTeam: An Application Lifecycle Management (ALM) tool intended for teams to manage the entire project lifecycle from requirements and test cases to tasks and code.
- SpiraTest: A test management, requirements management, and defect management software tool intended for teams to manage requirements, features, and use cases; create, edit, and execute test cases; track bugs, enhancements, risks, and issues; and generate personalized reporting.
- SpiraCapture: Enables exploratory testing and automatically records and organizes the test activities, then records them in SpiraTest. This tool is a free Chrome extension.
- RemoteLaunch: An automated regression testing extension for SpiraTest intended for teams to connect to their automated testing tools and allow SpiraTest to orchestrate testing activities, both manual and automated, in one place.
- Inflectra.ai: The first domain-specific GenAI engine embedded natively within Spira, purpose-built to accelerate your entire development lifecycle. As a cloud-native add-on, it offers a frictionless, secure, and intelligent experience for modern software teams.
- KronoDesk: Customer support & help desk ticketing software intended for customers to contact their supplier with queries and track it all from a one-stop shop support hub.

Vendor: Livepoint Software Solutions Ltd

- Swiftcase: A no-code visual workflow builder intended for teams to build their workflows, integrate the apps they already use, and automatically trigger actions based on the data collected in their workflow. Ensure adherence to regulations with automated compliance checks.

Vendor: MathWorks® Inc.

- Simulink Test: Provides tools for authoring, managing, and executing systematic, simulation-based tests of models, generated code, and simulated or physical hardware.
- System Composer: Enables the specification and analysis of architectures for model-based systems engineering and modeling of software architectures.

Vendor: Modelon Inc

- Modelon Inside: Expands existing platforms to strengthen collaboration within your enterprise by enabling models to be shared between departments, with an OEM, or suppliers across different platforms.

- Modelon Impact: Open standards-based system simulation software with a rich collection of ready-made libraries for aerospace, automotive, energy, and process simulation, and industrial equipment based on the open standard language Modelica and the open API for exchange of executable models FMI. Browser-based UI.

Vendor: Miro

- Intelligent Canvas: Let AI use your brainstorms and ideas to create product briefs and summaries to move work forward - no complicated prompts needed. All you need to do is provide content from your canvas, and let Miro AI handle the rest.
- Miro AI: Transform your ideas into polished outputs in minutes. With Miro AI, generate comprehensive documents, diagrams, and images by building off your ideas on the board.

Vendor: Naval Postgraduate School

- Open Seabird: Enables its users to free-draw swim lane activity diagrams, and then, if the diagram is valid, it automatically generates the corresponding MP text code or SysML2 code. MP code may then be run in MP-Firebird or MP-Gryphon to generate traces and see the code as a SysML activity diagram.
- Monterey Phoenix: A U.S. Navy-developed lightweight formal methods framework for human, technology, and environment behavioral modeling. MP can be used to extend SysML activity models for emergent behavior analysis and classify the behavior as weak, strong positive, or negative.

Vendor: OpenMBEE

- Cameo MDK Systems Reasoner: Convenience tooling for UML/SysML inheritance using the Block Specific Type pattern. Cameo MDK Systems Reasoner is an open source plugin for Cameo Systems Modeler and other No Magic environment bundles. Supports Cameo 2024x.

Vendor: Orcanos Israel

- ORCANOS ALM: An Application Lifecycle Management (ALM) tool intended for enterprises to plan, approve, trace, and validate industry requirements, manage audits, and ensure regulatory compliance, all within a seamless integration into a Microsoft Office environment.
- ORCANOS ALM/Design Control Suite: A tool suite intended for medical device manufacturers to manage product design data on a life cycle basis.
- ORCANOS Requirements Management Tool: Intended for both enterprise-size organizations and small and medium-sized businesses to simplify requirements tracking in the development lifecycle of medical devices. Meets FDA, ISO 13485, and IEC 62304 standards.
- ORCANOS Risk Management Automation: A risk management tool intended for medical device manufacturers to guide them along the right path to ISO 14971:2019 compliance in a single workflow. This system connects Design Control (ALM) and Quality Management to support compliance processes.
- ORCANOS ALM Test Management Tool: Intended for enterprises to execute test cases and report defects directly from a test run using the integrated bug tracking tool, record results, and track them using the Orcanos Dashboard Report. It works in conjunction with the ORCANOS Requirements Management Tool.
- ORCANOS Traceability Matrix Tool: An embedded part of the ALM Requirements Management Tool, the ORCANOS Traceability Matrix Tool is intended for enterprises to generate traceability matrices, perform an impact analysis, generate product inconsistency

alerts, create traceability matrix reports, and navigate traced items.

- ORCANOS Defect Tracking System: Designed to help your company's quality assurance by giving all of the participants in the development lifecycle a professional Defect tracking application and Defect reporting tools.
- ORCANOS Quality Management System Suite: A tool suite intended for medical device manufacturers to manage product quality on a life cycle basis. The QMS Software Suite captures the required data points for compliance and controls the quality processes from a single access point.
- ORCANOS Quality Management System: Intended for medical device manufacturers to manage compliance with MDR/FDA regulations and ISO quality standards by eliminating paper-based QMS processes.
- ORCANOS Supplier Qualification Management Software System: Highlights what's wrong and how to fix the problem. The system enables you to qualify suppliers, maintain an approved supplier list, and specify the specific products and services they provide as part of an integrated quality system.
- ORCANOS Audit Management Software System: Intended for medical device manufacturers to prepare and manage audits or inspections electronically. The audits are secure, web-based, traceable to your quality processes, and utilize workflows and e-sign automation.
- ORCANOS Change Control: Intended for medical device manufacturers to document and control the change management process and is compliant with FDA CFR Part 820. Features include full customization of an engineering change control process, status tracking, and managing KPIs.
- ORCANOS CAPA Management System: Enables medical device manufacturers to fully automate CAPA processes. While automating the processes, the system ensures regulation compliance from the initial investigation to closure. All processes and forms are customizable.
- ORCANOS Complaints Management System: Intended for medical device manufacturers to assure compliance with ISO 13485, particularly in the areas of complaint handling and labeling control.
- ORCANOS FMEA Risk Management: Manages compliance with ISO 14971:2019 and is targeted for medical device developers, and automates the entire risk management features, such as risk level calculation method and probability based on a hazardous situation.
- ORCANOS Document Control Software: Intended for medical device manufacturers to reduce the bottlenecks in document routing and sign-off. Orcanos Document Control Software simplifies and centralizes document management, giving you easy access and control at every stage.
- ORCANOS Customer Service: Integrated into the ALM Design Control and Quality Management system, and is intended for customers to report service calls, which your support team can later address. Achieve full MDR compliance for Post Market surveillance and Market surveillance.
- ORCANOS Training Management: In the medical device industry, compliance with regulations and maintenance of high-quality standards are of utmost importance. However, managing and tracking employee training can be a complex and time-consuming process. Our training management tools provide a comprehensive solution.

Vendor: OSSENO Software GmbH

- ReqSuite® RM: A requirements management tool used by organizations to analyze and

manage requirements more completely, easily, and in a standard manner to simplify the analysis, planning, and design in development or procurement projects.

Vendor: Planview, Inc.

- IdeaPlace: Innovation management software intended for enterprises to easily uncover ideas in the mind of an employee, partner, or customer, manage them, and bring them to market with minimal effort from your innovation team.
- Portfolios: Enables enterprises to accelerate strategic execution by integrating business and technology planning, optimizing all resources, and delivering breakthrough products, services, and customer experiences to achieve maximum business performance.
- PPM Pro™: A project portfolio management tool intended for enterprises to collect, prioritize, and execute projects, enabling PMOs to focus resources on the work that delivers the most value, optimizes project portfolios, and balances capacity against demand, prioritize work.
- ProjectPlace™: Project management software intended for dispersed teams to provide everything you and your dispersed team need to manage group projects and complete daily tasks.
- AgilePlace: Enables organizations and teams to use enterprise Kanban boards to visually track and manage the flow of work from strategy to delivery.

Vendor: Psoda

- Psoda Portfolio Management: Intended for enterprises to plan, track, and report on their project portfolios. It has everything needed to make informed decisions at the right time using dashboards, scoring metrics for alignment, workflows, and reports.

Vendor: PTC

- PTC Product Lifecycle Management: Enables geographically dispersed, multidisciplinary product teams to strategically collaborate using trusted up-to-date product information. PLM is the foundation for the digital thread, delivering supply chain agility and business continuity.
- PTC Windchill: Product lifecycle management software intended for manufacturers to realize value quickly with standardized, out-of-the-box functionality across a comprehensive portfolio of core PDM and advanced PLM applications.
- Windchill Navigate: A data access tool intended to provide non-experts with simplified access to PLM content and workflows and provide a variety of information from other sources, such as requirements, analytics results, drawings, and 3D models.
- FlexPLM Retail PLM: A fashion or retail PLM platform intended for retailers to deliver digital transformation, revolutionize remote working and collaboration, and unlock technologies like visual line collaboration, 3D, and embedded AI.
- PTC Modeler: Helps your systems and software engineers create consistent, high-quality models to communicate requirements, identify key functions, consider design alternatives, and make good trade-off decisions using UML, SysML, or UAF modeling languages.
- Vuforia: A comprehensive, scalable enterprise Augmented Reality (AR) platform for developing powerful step-by-step AR instructions. Our wide-ranging solution suite ensures that we can provide the right AR technology to every customer based on their business needs.
- PTC Service Lifecycle Management (SLM) Software: Intended for companies to maximize service efficiency and increase customer success. Successful SLM utilizes four main stages: connection to the asset, orchestration of resource delivery, execution of work, and a good

data foundation for optimization.

- Service Knowledge and Diagnostics: An interactive diagnostics tool intended for service businesses to do connected interactive diagnostics that automate issue diagnostics and enable remote diagnostics of smart, connected products (SCP), an intelligent knowledge base system.
- PTC ThingWorx Asset Advisor: Asset management solution intended for service managers and technicians to remotely monitor, manage, diagnose, and resolve issues for their connected equipment in the field.
- PTC Arbortext: A structured authoring tool intended for technical authors to generate technical documentation like service manuals and parts catalogues. Creating, managing, and delivering content in an efficient way requires a system that ensures every element of the process is simple – and smart.
- PTC Servigistics: An inventory management system intended for companies to optimize their inventory to ensure they have the right part in the right place at the right time for the right price. Servigistics revolutionizes service supply chain optimization with purpose-built industrial AI innovations.
- ServiceMax AI: Leverages the full documented history of a field asset stored in the ServiceMax® platform, including equipment data, service history, and known service resolutions, to help field service technicians get more done in less time.
- ServiceMax Zinc: Give your dispersed team members the remote assistance capabilities they need to see, understand, and act in real time. Bring your technicians and experts together to collaborate and solve problems - from anywhere. On-screen markup stays where the experts put it as they move through procedures. (part of the Vuforia suite)
- PTC Warranty: Warranty management software intended for product owners to streamline and automate all of the key aspects of warranty management to help reduce costs.
- PTC Creo View Visualization Software: Intended for design authors, project managers, and downstream suppliers to quickly and easily access and share multiple forms of engineering data between themselves and other stakeholders, both interactively at their desktop or through augmented reality (AR).
- PTC Creo Illustrate: Illustration tool intended for illustrators to create rich 3D technical illustrations, 2D drawings, and interactive animated sequences that accurately reflect current product configurations and support formats from hard copy to augmented reality.
- Creo CADDS: An adaptable, hybrid modeling solution that leverages parametric, explicit, and derived modeling capabilities that are tailored to meet the needs of shipbuilders and other designers of very large complex systems.

Vendor: QRA

- QVscribe: A natural language requirements quality analysis tool intended for teams to proactively check written requirements against requirements best practices identified by associations such as INCOSE and leading industry experts. Integrates with multiple requirements management tools.

Vendor: Ravenflow

- RAVEN for Microsoft Office: A requirements management plugin for Microsoft Office intended for requirements writers to produce rich visualizations in a single click, transforming your natural language descriptions into diagrams and requirements specifications that others can understand and validate.

Vendor: REQTEAM GmbH

- ReqEdit: A collection of modules supporting and implementing requirements management and data exchange capabilities between tools using the ReqIF data exchange standard to simplify the flow of requirements between suppliers and product producers using ReqIF for the data exchange of requirements.
- ReqEdit Client: Designed as a simple, portable ReqIF editor for Windows OS users for displaying and editing data. It can edit existing requirements and create new requirements documents.
- ReqEdit Server: Offers you a central place to organize your requirements data and is also able to communicate with the connected ReqEdit Clients.
- ReqEdit Reader: A free, read-only version of ReqEdit intended for users to view ReqIF files (Open standard for exchanging requirements in automotive, aerospace, transportation, or pharmacy industries), preserving the document structure, formatting, and all embedded files (Word, Excel, PDF, jpg).
- ReqEdit Word Add-On: A converter for Word files into ReqIF files intended for users to convert a complete MS Word file into one ReqIF document, keeping the formatting of the text and attached files.
- Add-On Excel-Reqif: A converter for Excel files into ReqIF files. The software converts worksheets into ReqIF Specification documents with the formatting of the text, attached files, and links between rows.
- ReqEdit Batch Mode with CLI incl. RoboTask: ReqEdit Batch Mode, using software called RoboTask© (www.robotask.com), enables the conversion of all new incoming files into ReqIF and RIF. In combination with RoboTask, proceeding several commands together to automatically send e-mails for updated files.

Vendor: Rockwell Automation

- Arena® Simulation Software: Provides business process and discrete event simulation that is being applied to a wide range of industries to evaluate business process decisions before they are put into practice.

Vendor: Siemens PLM Software

- Teamcenter: A modern, adaptable product lifecycle management (PLM) system that connects people and processes across functional silos with a digital thread for innovation. The robust Teamcenter portfolio depth helps solve the challenges required to develop highly successful products.
- Simulation Process and Data Management: A solution for teams to get control of simulation data and processes to avoid common problems such as analyses performed on obsolete data, poor visibility to simulation results, and results arriving too late to drive design direction.
- Electrical CAD Management: A solution intended for teams to automate engineering change, validation, and approval processes while collaborating across locations and extended supply chains on design data, revisions, and product configurations.

Vendor: SOFTEAM

- Modelio BA - Business Architecture: A modelling tool intended for business architects to model data, business processes, and architectures compliant with "metamodels" defined by the OMG UML and BPMN standards. providing analysts with all the standard diagrams, enabling them to express ideas.
- Modelio BA Enterprise Architect: Supports architects and analysts developing enterprise architecture, TOGAF, BPMN, and UML models. EA also supports vision, goals, and

requirements as defined architecture framework development methods.
- Modelio SD - Software Development: A modelling tool intended for software developers to manage the software development process from requirements analysis through to generated code.
- Modelio Analyst: A possible extension to Modelio SD - Software Development, intended for software developers to provide complete support for requirements management, and it is included in Modelio BA.

Vendor: Sparx Systems
- Enterprise Architect: Sparx Systems specializes in high-performance and scalable visual modeling tools for the planning, design, simulation, and construction of software, embedded, and real-time systems.
- Prolaborate: Sharing & Collaboration Software for Enterprise Architect. It connects Enterprise Architect modelers and business teams to enable informed decision making in real time. On-premises and cloud application that enables remote modelling and architecture integration in your repository.

Vendor: Stanford University School of Medicine
- Protégé: A free, open-source ontology development environment for the Web that makes it easy to create, upload, modify, and share ontologies for collaborative viewing and editing. it is available for downloading or using via the Web from Stanford University.

Vendor: Tricentis GmbH
- Tricentis qTest: A suite of Agile testing tools that provide scalable test management, operations, and analytics to centralize testing and orchestrate quality at speed, with visibility throughout the software development lifecycle.
- Tricentis qTest Launch: Part of the Tricentis qTest test tool suite, qTest Launch can manage multiple test machines from a single location, schedule test automation sequences, and scale test automation to an enterprise level.
- Tricentis Tosca: A scriptless, AI-based, no-code approach for end-to-end test automation. Tricentis Model-Based Test Automation (MBTA) provides rapid authoring of resilient tests that are easily maintained, enabling 90% automated test coverage from release to release.
- Tricentis Visual Reporting: An enterprise continuous testing, analytics, and reporting tool. It provides portfolio-level visibility of your testing activities and can consolidate, manage, and analyze tests across the Tricentics Continuous Testing Platform.

Vendor: VENTANA Systems, Inc.
- Vensim: Modeling and simulation software for analysts, consultants, and researchers worldwide for building high-quality simulation models in business, scientific, environmental, and social systems. Emphasizes model quality, data connections, and advanced algorithms.

Vendor: Vincent HOLLEY, PhD. Eng.
- GEEGLEE: A software solution used for trade-off analysis, systems engineering, product architecture exploration, innovation, development road map, tenders, and manufacturing.

PPI SyEN readers are encouraged to check out these new and updated systems engineering tool offerings.

Access the SETDB website.

CONFERENCES, MEETINGS & WEBINARS

Events of relevance to systems engineering

IIBA Webinar: The Process Mapping Toolbox - Free Tools

The International Institute of Business Analysis (IIBA) is hosting a free open-access business analysis webinar on 3 September titled *The Process Mapping Toolbox: Part 1 - Free Tools*. Scott Helms of the Harvard Computing Group and a Visio expert will demonstrate his best process mapping tips using various free tools, as well as using Visio, LucidChart, and TaskMap. Topics to be addressed include:

An introduction to process mapping and its importance in business analysis

- Demonstrations of key features of various tools
- A discussion of the PROs and CONS of each tool
- Tips for selecting the best tool for your organization
- Practical examples to help you get started right away

This webinar is Part 1 of a four-part series. Learn more and register here. Non-members of IIBA can create a free account on the IIBA site in order to register.

View prior IIBA public webinars here.

Learn more about the IIBA and its membership options.

Program Details International Modelica & FMI Conference 2025

Modelica is a freely available, equation-based, object-oriented language for convenient and efficient modeling of complex, multi-domain cyber-physical systems described by ordinary differential, difference, and algebraic equations. The Modelica language and the companion Modelica Standard Library have been utilized in a variety of demanding industrial applications, including full vehicle dynamics, power systems, robotics, buildings and district energy systems, hardware-in-the-loop simulations, and embedded control systems. The Functional Mock-up Interface (FMI) is an open standard for the tool-independent exchange of models and for co-simulation.

The International Modelica & FMI Conference 2025 will take place as a face-to-face conference on 8-10 September in Lucerne, Switzerland. It is organized by HSLU, the University of Applied Sciences and Arts Lucerne, in cooperation with the Modelica Association.

Keynotes for this conference include:

Physics-Informed AI (Mishra Siddhartha, ETH Zürich)
AI is increasingly being used in the fast and accurate simulation of physical systems. In this keynote, we will discuss how knowledge of the underlying physics can be explicitly incorporated into AI systems

for physical simulations. Key examples will highlight the potential gains as well as the involved challenges.

Opportunities and Challenges in Design and Operation of Integrated Energy Systems (Johan R Åkesson, Carrier)
The complexity of modern integrated energy systems demands the systematic use of systems engineering methods and tools to address key challenges across the product lifecycle. This keynote will explore three related and critical areas: 1) the demand for diverse model fidelities and analysis, 2) maintaining consistency across design layers, and 3) the importance of seamless tooling and integration. Real-world, HVAC-specific examples will highlight how these challenges are being tackled in practice and the opportunities they present.

The conference offers a wide range of tutorials on topics such as:

- Beyond Simulation: Building Workflows and Web Applications with Modelica and Python
- eFMI®: A beginner's overview and hands-on
- FMI Beginners Tutorial - Exporting, Simulating, and Co-Simulating FMUs
- Introduction to Modeling, Simulation, Debugging, and Interoperability with Modelica and OpenModelica
- Modelica in the Browser: Modeling, Simulation, and Web App Integration for Custom UI
- Modeling and Simulation of Robotic Arm Dynamics and Control in Modelica with MWORKS
- Modeling complex thermal architectures using the DLR ThermoFluid Stream Library
- Regression Testing with Dymola and the Testing Library
- System Structure and Parameterization

View the preliminary technical program here.

Register here.

Upcoming PDMA Learning Opportunities

The Product Development Management Association (PDMA) is offering several learning opportunities in September, October, and November to advance product development and innovation skills.

AI-Powered Product Development: Strategy, Execution & Metrics (4 September)
In this free webinar, Latha Ramamoorthy, Technical Product Manager at JPMorgan Chase, will explore how AI is revolutionizing new product development (NPD) by enabling smarter decision-making, predictive analytics, and automation. This webcast will explore how AI-driven strategies optimize product development cycles, improve execution efficiency, and introduce new success metrics. This session is tailored for product managers, business leaders, and AI enthusiasts seeking actionable insights on leveraging AI to drive innovation, improve efficiency, and stay competitive.

Key takeaways include:

- How AI enhances product strategy & decision-making
- AI's role in market research, predictive analytics & customer insights
- Implementing AI-powered execution frameworks for product teams

- Measuring success: KPIs & AI-driven performance metrics
- Real-world use cases from the financial & technology sectors

2025 Fall Body of Knowledge Training (Tuesdays – 23 September through 4 November).
The PDMA Carolinas chapter is conducting an online seven-week professional development training program that covers the fundamentals of product management and innovation. During this series, expert product development practitioners and talented educators will be teaching seven key areas of study, including:

- Strategy
- Product Innovation Management/Life Cycle Management
- Product Innovation Process
- Product Design and Development Tools
- Portfolio Management
- Market Research
- Culture, Teams, Leadership

Program benefits include:

- Learning methods and tools by applying them to your own business challenges during and after class
- Interacting with instructors with various areas of expertise and backgrounds
- Collaborating with participants from diverse industries

Attendees may register for the full 7-week program or individual sessions.

Program Details: PDMA Ignite Innovation Summit

Program details have been released, and registration is open for the 2025 PDMA Ignite Innovation Summit (Annual Conference). This event will be held jointly with the Journal of Product Innovation Management (JPIM) Research Forum on 13-16 September 2025 in Chicago, Illinois, USA.

Keynote speakers for the Summit include:

- Bennett Brenton, CIO, Snap-on Corporation: *Creating a Culture of Fearless Innovation: Process and People*
- Robin Champ, Vice President, Strategic Foresight, LBL Strategies: *The Foresight Edge: Building Adaptive Strategies for a Resilient Future*
- Jod Kaftan, Digital Experience Design Sr. Director, Launch by NTT Data: *Re-Thinking Product Experiences with Strategic Foresight*

The event offers a wide range of learning and networking opportunities, including hands-on workshops, mastermind sessions, and speaker presentations. A sample includes:

- Creating Customer Magic: How to Infuse a VOC Mindset to Fuel Insights for Innovation (Presentation)

- Innovating for the Unseen User: How Pella Redefined Market Success by Focusing on Installers (Presentation)
- Inside the Innovation Engine: How Michelin and BMW are Cultivating Intrapreneurs through Bold Partnerships (Presentation)
- Research to Reality (Mastermind session)
- The Danger of a Single Future (Presentation)
- Unprecedented Product Intelligence with AI (Presentation)
- War Games (Workshop)
- Will SYSTEM THINKING Ignite or Destroy Innovation Success? (Presentation)

Investigate the conference schedule.

Register here.

Forum on specification and Design Languages (FDL 2025)

The Forum on specification and Design Languages (FDL 2025) is scheduled for 10-12 September 2025 in St. Goar, Germany. FDL is an international event where academics and industrial experts exchange their experiences, advances, and share the new trends in the languages and techniques used in any phase of the development process of hardware and platform-based Cyber Physical Systems (CPS).

Program details for FDL 2025 have been released.

Keynotes for FDL 2025 include:

- Consistency and Timing in Distributed Systems (Edward A. Lee, University of California at Berkeley, USA)
- How to Systematically Design Imperfect Systems? (Samarjit Chakraborty, UNC Chapel Hill, USA)
- Semantics as Infrastructure: Reconnecting Behavioral Modeling and Formal Analysis (Ciprian Teodorov, ENSTA, Institut Polytechnique de Paris, France)

A sample of the planned technical presentations includes:

- Equation-based Modelling of Physical Systems using Modelica
- Leveraging the Benefits of Information Flow Tracking for Detecting Hardware Design Flaws
- Multi-paradigm modelling
- Performance Modeling and Analysis of Exposed Datapath Architectures
- ProtoLens: Dynamic Transaction Visualization in Virtual Prototypes
- Tool Support for Precise Assessment of Software Security/Performance Tradeoffs
- Virtual Prototyping and Interoperability Standards in Multidisciplinary Design

Register here.

View the proceedings of prior FDL events on IEEE Xplore®

CONFERENCES, MEETINGS & WEBINARS

INCOSE Western States Regional Conference (WSRC 2025)

Registration is open for the INCOSE Western States Regional Conference (WSRC 2025) to be held in Bothell, Washington, USA, on 11-13 September 2025. The eighth annual WSRC, hosted by the INCOSE Seattle Metro Chapter, showcases the latest innovations in Systems Engineering research and real-world applications and solutions in support of the theme, *Systems Engineering - the Blueprint for Everything!*

Registrants may choose from optional tutorials on 11 September:

- Accelerating Digital Engineering with MBSE & Virtual Twin - A Hands-On Robotic Arm Workshop Using SysML and Catia Magic / Cameo
- Introduction to Pythonic Systems Engineering
- Leveraging Lifecycle Modeling to Integrate Systems Engineering and Project Management
- SysML V2 Finally in Practice: An Interactive Beginner's Tutorial
- SysML V2 Fundamentals

A sample of planned technical presentations includes:

- AI-Driven Traceability & Consistency for Systems Engineering
- Alignment of Agile and Modular Open Systems Approach (MOSA) Principles in Systems Engineering
- Analysis of Systemic Failures in Application of Failure Modes and Effects Analysis in V-Model Based Complex Design
- Future-Proofing Aviation Maintenance — The Role of Industry 5.0 in Workforce Sustainability
- IoT Adoption for Smart Systems – A Systems Engineering Approach to Scalable, Secure Integration
- Is Functions-Based Systems Engineering (FBSE) Dead?
- Navigating the Challenges of Successful Automation: A Case Study Presentation
- On the Usability of Model-Based Systems Engineering Tools: A Heuristic Evaluation Approach
- Reliability to Resiliency: Exploring Interconnected Metrics of System Performance

View the program details. Register here.

Swiss Systems Engineering Day 2025 (SWISSED25)

The Swiss Society of Systems Engineering (SSSE) is hosting the annual Swiss Systems Engineering Day 2025 (SWISSED25) in Zurich on 15 September. The conference theme is *SE: Stories Experienced*, supported by 18 presentations where systems engineering professionals from across Europe will share practical insights, challenges, and lessons from real-world projects.

Keynotes include:

- Beam Me Up—But Safely: Systems Engineering at the Energy Frontier (Mike Lamont,

Director for Accelerators and Technology at CERN)
- MBSE-assisted Integration and Verification of SKA-Low: Building the World's Largest Radio Telescope in the Australian Outback (Lucio Tirone, Assembly, Integration, and Verification Lead Engineer, Square Kilometer Array Observatory)
- Systems Engineering Vision 2035 – Turning Fiction into Fact (Prof. Michael C. Jackson, Emeritus Professor, University of Hull and Managing Director, Systems Research Ltd.)

Learn more about SWISSED 2025.

Register here.

Follow SSEE on LinkedIn.

Digital Thread Conference 2025

The Digital Thread Conference 2025 will take place on 10-11 September. This free virtual event is hosted by Intercax, developers of the Syndeia™ digital thread platform for model-based engineering. The conference will provide an opportunity for digital engineers and Syndeia users to share digital thread stories, exchange ideas, and learn about emerging digital engineering technologies.

The conference theme, *Digital Threads – Foundation for Digital Engineering and Digital Twins*, is reflected in presentation topics such as:

- Advancing an MBSE Method with SysML v2
- Application of Model-based Approaches for Earth Observation Missions
- *Business Value of Digital Threads and Digital Engineering*
- *Custom Project Dashboards and Metrics powered by Digital Threads*
- *Establishing and Maintaining Digital Threads in Support of Digital Engineering Strategies*
- *NASA's Digital Engineering Strategy*
- *Syndeia Roadmap – Models, Threads, Intelligence, and Dashboards*
- *Unifying Systems, Design, Simulation, and Verification with Digital Threads*
- *Wiring the Future: Digital Threads for Complex Aerospace and Defense Systems*

Register for the Digital Thread Conference 2025.

Capella Online Training

Obeo is offering online training courses on the Arcadia method and Capella open-source MBSE software. The training introduces Model-Based Systems Engineering (MBSE) and implements the Arcadia method and Capella tool on a simple case study. It covers system definition activities such as operational analysis, functional and non-functional system analysis, logical architecture, and physical architecture.

Each course is delivered in the form of six 3.5-hour online sessions, with four series currently open for enrollment:

- 29 September – 8 October 2025

- 6-13 October 2025
- 3-12 November 2025
- 1-8 December 2025

At the end of the training, participants should be able to:

- Acknowledge the principles, key points, and expected benefits of the MBSE approach
- Describe the steps (perspectives) and the activities of the Arcadia method
- Implement Capella functionalities on a simple case
- Navigate through the different types of support on Arcadia and Capella

This Capella training is run in English by an MBSE expert who is part of Obeo's global partner network.

Learn more. Download the course flyer.

Register here.

R&D Innovation & Design Thinking World Summit

Preliminary program details are emerging for the 7th Annual R&D Innovation & Design Thinking World Summit that will take place in Amsterdam, The Netherlands, in October. The objective of the Summit is to foster a holistic and integrated approach to both product development and innovation – by delving into methodologies that facilitate the rapid, flexible, and interconnected nature of modern R&D processes.

An early sample of highlighted topics includes:

- A Journey from Commodity to Innovation Powered by Agile Practices
- Comprehensive Approach to Measuring R&D Effectiveness
- Design Thinking for Transformational Innovation in Consumer Care and R&D's Unique Leadership Responsibility
- Digitally Transforming an R&D Organization – Journey at Frieslandcampina
- How Data and Metrics Make You Lose Focus on the Customer
- Innovating in a Resource-Constrained Environment
- Innovation Unleashed: Cultivating Creativity, Collaboration, and Success
- Leveraging Automation Capabilities on the Design Process
- The AI Innovation Flywheel: Why Democratizing Design Thinking Is a Matter of Survival
- The Future of Research and Development: Paving the Way for a Sustainable Future

Request the conference brochure.

Festival of Business Analysis 2025

IIBA® Australia Chapter

The Australia chapter of the International Institute of Business Analysis™ (IIBA®) is hosting the Festival of Business Analysis (FOBA2025) on 13-24 October 2025. The theme of this hybrid multi-site (Australia and New Zealand) conference is "*Rethink. Reconnect. Revolutionise*" inviting participants to challenge

conventional thinking, build meaningful relationships, and explore transformative solutions that drive real impact

The in-person elements of this conference will move across New Zealand and Australia as follows:

- 20 October – Wellington
- 21 October – Auckland
- 21 October – Adelaide
- 21 October – Perth
- 22 October – Brisbane
- 23 October – Melbourne
- 24 October – Sydney

The online portion of the conference will run from 13-17 October and have a unique speaker lineup.

A sample of the topics to be addressed across the various sites includes:

- *A matter of life and death – when your requirements traceability has to be right; the work of a BA in the healthcare industry*
- Aggregating Chaos: Where Machine Learning and the Real World Collide
- AI Agents as Copilots: Transforming Business Analysis
- Analysis in the Accelerated World
- Becoming antifragile is more important than ever in disruptive times
- Beyond Features: NFRs as Delivery Superpowers
- Brain-Based Techniques for Managing Difficult Stakeholders
- *Business Architecture: a Gentle, Pragmatic, and Practical Introduction*
- From Vision to Structure: Thinking Like an Architect
- Historic Failures and Future Instruments
- *I'm a BA – not a bot! Why AI will never replace us*
- *Insights Into a Digital Transformation Journey*
- *Knowledge as Part of Every Business Solution*
- *Metrics that Matter: How Do We Use Product Value Flow to Eliminate Waste*
- *Panel: Business Analysis 3.0: Human-Centred, Tech-Enabled, Boldly Evolving*
- *People-Powered Agile: Transforming Teams through Human-Centric Analysis*
- *Shrinking the Pie: Making a Case for Controlling Risk*
- *So, you think you know use cases?*
- *Starting our initiatives the right way using engaging visual models*
- *The Lost Art of Use Cases*
- *Workshop: Revolutionising Decision-Making with AI-powered Digital Twins*

Learn more and register.
View prior-year events (2022, 2023, 2024).

CONFERENCES, MEETINGS & WEBINARS

Joint Symposium of the Resilience Engineering Association and Resilient Health Care Society

The Joint 11th Biennial Resilience Engineering Association (REA) Symposium and the 14th Annual Resilient HealthCare Society (RHCS) Meeting will be held in Canela, Brazil, on 20-24 October 2025. This will be the first joint REA and RHCS conference. The theme of this event is "*Collaboration Across Boundaries for Adaptation in the Era of Complexity*".

Keynotes for this event include:

- The fifth paradox of safety (Erik Hollnagel)
- Floods in the State of Rio Grande do Sul in 2024: Examining the past and preparing for the future (Joel Avruch Goldenfum)
- Health system resilience (Victoria Haldane)

Day 1 of the symposium (20 October) has been designated as RE in Practice Day and is dedicated to industry testimonies, including a keynote on the catastrophic flooding in the host region of Brazil during April-May 2024.

Check for details on the evolving program here.
Register here.

Asia Oceania Systems Engineering Conference (AOSEC 2025)

The 15th Asia Oceania Systems Engineering Conference (AOSEC 2025) will be held in Singapore on 27-29 October 2025. Attendees can expect to hear from leading experts in the field, participate in engaging workshops, and network with peers from around the world.

TOPICS OF INTEREST INCLUDE:			
Aerospace	Agile SE	Artificial Intelligence for SE (AI4SE)	Automotive
Defence	Digital Engineering	Environmental Sustainability	Industrial Symbiosis
Marine & Offshore	Model-based SE (MBSE)	Medical	Natural Systems
Nuclear & Renewable Energy	Rising Sea Level	Smart Cities & Sustainability	SE for Brownfield Development
Space	Systems Security	Systems of Systems Engineering (SoS)	Transportation

Learn more about AOSEC 2025. Register here.

NDIA Systems and Mission Engineering Conference

The U.S. National Defense Industrial Association (NDIA) is hosting its 28th Annual Systems and Mission Engineering Conference in Tampa, Florida, on 27-30 October 2025. This in-person conference targets the U.S. defense

community, including representatives from industry, government, and academia. The theme of this year's conference is *DoD Mission-Ready: Digital Transformation Across the Systems' Lifecycle*.

Presentation topics span the following areas:

- Actionable Architecture / MOSA Impact
- Artificial Intelligence (AI)
- Education & Training
- Enabling Agile Throughout the Lifecycle
- Digital Engineering and Environments (DEE)
- Digital Twin
- Mission Engineering / System of Systems
- Model-Based Systems Engineering (MBSE)
- Physics-Based Modeling & Simulation
- Program Management
- Specialty Engineering (Human Systems Engineering)
- Specialty Engineering (Safety and Environmental Engineering (SEE))
- System Security Engineering (SSE)
- Test & Evaluation

A sample of the available workshops includes:

- Agile Systems Engineering
- AI for Systems Engineering & Systems Engineering for AI
- Digital and Data-Driven Engineering
- DoD Resources
- Systems Engineering Modernization

Learn more here. Register here.

EHS Congress London

The Environmental, Health and Safety (EHS) Congress 2025 London will take place on 28-29 October. 120 EHS leaders are expected for this in-person event that features industry experts sharing insights through presentations, panels, and interactive workshops. The range of expertise includes:

- High-level strategy
- Boots on the Ground" experience
- Academic rigor

Download the preliminary conference agenda.

Register here.

New Zealand Systems Engineering Conference

Registration is now open for the New Zealand Systems Engineering Conference that will take place in Auckland on 11-12 November. The theme of this in-person event is *Navigating Complexity with Confidence*. To support this theme, presentations are planned that address the application of systems engineering to a variety of challenges faced in New Zealand, including:

- Case studies for New Zealand projects
- Systems of Systems activities
- Systems Thinking applications
- Sustainable development considering Kaitiakitanga
- Addressing UN Sustainable Development Goals
- Addressing the New Zealand Infrastructure Gap
- Human-Systems Integration in Aotearoa
- Industry applications of systems engineering and Kiwi success stories
- Tailoring of systems engineering for a New Zealand context
- Case studies for NZ projects involving systems engineering

The preliminary conference schedule has been published, with details to be added shortly.

Register here.

Capella Days 2025

The annual free online gathering of the Capella (MBSE tool) and Arcadia (MBSE method) community, Capella Days 2025, is scheduled for 18-20 November. Capella Days bring together the creators of Capella/Arcadia, providers of Capella add-ons and services, and MBSE experts and industrial users.

A Call for Proposals has been issued, seeking feedback from industrial users concerning their application of Capella and best practices in doing so. Topics of interest for these online presentations include:

- MBSE challenges
- Arcadia methodology adoption
- Capella integration and deployment
- Lessons learned

The final submission deadline for proposals is 7 September. The final program will be announced on 18 September.

Learn more about Capella Days 2025. Submit your talk.

FEATURE ARTICLES

The Challenges of Establishing an Authoritative Source of Truth in a Data-Driven Engineering Ecosystem

by Warren K. Vaneman, Ph.D., ESEP

Authored for PPI SyEN

Abstract

Establishing an Authoritative Source of Truth (ASoT) in a Data-Driven Engineering (DDE) ecosystem is essential yet complex. This paper explores the technical, semantic, and organizational challenges of integrating diverse data sources across the system lifecycle. It argues for a shift from model-centric to data-centric thinking, emphasizing the need for standardized ontologies, semantic alignment, and concordance. The Lifecycle Modeling Language (LML) and set theory principles are proposed as foundational tools for structuring and verifying data relationships. Artificial Intelligence (AI) is positioned as a critical enabler, offering capabilities such as automated schema matching, real-time data fusion, and adaptive learning to manage the combinatorial complexity of integration. The concept of a Data-Driven Spectrum is introduced to illustrate how data evolves and compounds across the lifecycle, culminating in a dynamic digital twin. Ultimately, the paper advocates for AI-enabled, ontology-governed integration to realize a trusted, scalable ASoT that supports informed, timely decision-making.

Introduction

Systems engineering has been undergoing a renaissance to transform from a document-based to a model-based approach since the International Council on Systems Engineering (INCOSE) defined and popularized the term “Model-Based Systems Engineering” (MBSE) (INCOSE 2007). This sea change was prompted by a need to address the increasing complexity of systems where the models can appropriately be tailored to changing conditions and needs, reused, and able to observe the system architecture from a static perspective, or explore system behavior from a dynamic perspective. Model-Based Systems Engineering emerged to address increasing system complexity. Typically, MBSE uses a single tool and repository to offer various engineering and programmatic perspectives, but complex systems may require multiple modeling tools to address different system aspects for informed support to decision-making.

Digital Engineering (DE) was later developed as “an integrated digital approach that uses authoritative sources of system’s data and models as a continuum across engineering disciplines and tools to support acquisition lifecycle activities from concept through disposal” (DoD, 2018). Three goals of DE that are applicable to model development and management are (DoD, 2018):

- Formalized model development to establish the virtual representation of the system.
- The establishment of an Authoritative Source of Truth (ASoT), which thoroughly investigates and selects the best models to represent a given aspect of the system.
- The exchange and integration of models and data sources between disparate system lifecycle disciplines, modeling languages, tools, and presentation frameworks, while maintaining and storing their native format.

However, in spite of the almost two-decade emphasis placed on MBSE and DE, systems engineering methods have failed to keep pace with the ever-increasing complexities of systems. The focus on modeling artifacts, rather than data, makes the exchange and integration of data, and the establishment of an ASoT virtually impossible. To realize the three goals of model development and the management goal of DE, a data perspective is needed.

The Data-Driven Engineering Ecosystem

At the heart of MBSE and DE are different models that represent the various aspects of the system. For example, the System Modeling Language version 1.6 (SysML) uses nine diagrams that represent the key perspectives of the system. The commonly accepted approach for DE is to enable the integration and interoperability of models, data, and tools (DoD, 2018; DoDI 5000.97, 2023). These modeling methods often result in uncoordinated, repeated duplication of system elements because they focus on the model rather than the system itself. This prevailing approach is fraught with challenges of model interoperability and semantic inconsistencies.

Integrating models across various system lifecycle domains is essential for comprehensive system design and analysis, but achieving interoperability remains a significant challenge. Without standardized data formats and interfaces, models cannot effectively communicate or share information. Establishing modeling standards, formats, and interfaces is difficult because lifecycle domains often use incompatible tools and methodologies. Legacy tools further complicate integration, as they may not support modern standards or open interfaces.

Even when models are technically interoperable, semantic inconsistencies - such as differing assumptions, definitions, or units - can undermine their effectiveness. These mismatches can lead to misinterpretations, flawed outputs, and reduced trust in integrated systems. Harmonizing semantics across domains is a key challenge in achieving meaningful model integration because different domains often use varying definitions, assumptions, and terminologies for similar concepts. These inconsistencies can lead to the misinterpretation of data and flawed integration across systems.

The emphasis should be placed on the system as represented by data, which serves as a virtual depiction of the actual system, rather than solely on the model itself. This system-centric approach continues to utilize modeling tools for model creation, but emphasizes data integration, ensuring that each piece of data is represented only once within the virtual representation of the system, mirroring its singular occurrence in the actual system. The dodecahedron shown in Figure 1 (Vaneman, 2024) is a virtual representation of the system where data is created in models, using various tools, but is represented once, and has the relationships and attributes found in the actual system. In this example, the system consists of 12 dimensions; however, this data-driven engineering method can accommodate n dimensions, depending on the requirements of the system problem.

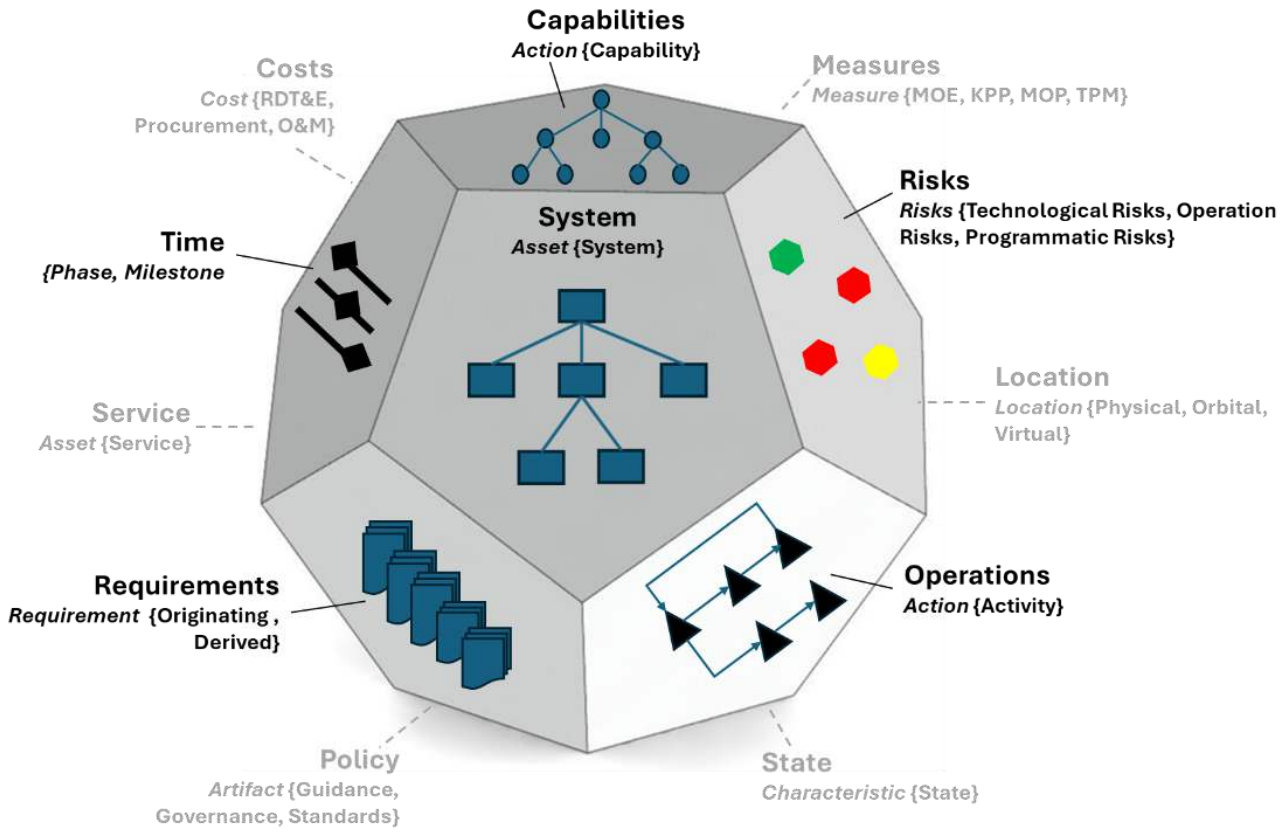


Figure 1. Virtual Representation of a System with 12 Dimensions (Vaneman, 2024).

A Data-Driven Engineering (DDE) Ecosystem is a federated environment where data is integrated from diverse models and multiple disciplines, through a common ontology, into an Authoritative Source of Truth, enabling a data-driven spectrum across the system lifecycle. The key attributes of DDE are:

- **Data Integration** - The ability of diverse data, developed using different modeling tools and standards, from multiple lifecycle disciplines, to be shared and integrated to form a comprehensive view of the system.
- **Concordance** – The ability to represent entity data so that it is consistent across different model views' level of abstraction (Vaneman, 2016).
- **Lifecycle Integration** - The correlation and integration of data across all phases of the system lifecycle.

Establishing a virtual representation of the system is fundamental to DDE, as it centers attention on the subject being modeled - the system itself. Data defines the system, requiring the implementation of a foundational ontology to enable standardized terminology, relationships, and attributes. This approach solves one of the problems inherent within MBSE, where each entity may be represented multiple times. Data-Driven Engineering represents a significant advancement in modeling the virtual representation of the system by promoting the notion of concordance, and allows for complexity to be managed more efficiently because data is the commodity being encapsulated, where systems engineering views are generated from the data, and are not stand-alone diagrams.

Understanding correlation is fundamental to analyzing the data used in system modeling. Correlation reveals the relationships between different data entities. In formal data development, three key elements are involved: corroboration, which supports the definition of the ontology; correlation, which identifies the interconnections among data; and concordance, which ensures that data is

consistently represented within the model as a virtual reflection of the system.

The Authoritative Source of Truth

The Authoritative Source of Truth (ASoT) is a trusted and reliable "virtual repository" that provides accurate and definitive engineering data from various trusted sources, which have been determined to be valid and reliable, that, when combined, the data represents various aspects of the real-world system across the system lifecycle. The ASoT serves as the central reference for data and models across the system lifecycle, provides traceability throughout the model, and represents the most credible data, originating from a trusted and governed repository, and is used where the data is singular and exhibits concordance. It is governed by ontology and is continuously evaluated to mitigate risks of using inaccurate data.

Conventional thinking often focuses on the digital artifact as the foundation of the ASoT. However, while bringing digital artifacts together may ensure that data from trusted sources are represented in a common, or virtual, repository, it does not allow for the representation of a comprehensive model and will not likely yield concordance. The ASoT is governed by a foundational ontology that serves as the atomic level of the model. It is from this foundational level that data from different modeling languages, tools, and other sources can be exchanged and combined to achieve concordance.
An ontology is defined by Budin (2005):

"An ontology encompasses a representation, formal naming, and definition of the categories, properties, and relations between the concepts, data, and entities that substantiate one, many, or all domains of discourse. More simply, an ontology is a way of showing the properties of a subject area and how they are related, by defining a set of concepts and categories that represent the subject."

A fundamental premise of an ontology is that it employs an economy or entities approach by reducing seemingly disparate entities from various program data dictionaries to the "atomic level" using a foundational set of entities. An ontology having too many entities will introduce ambiguity into the model by using different entities to represent the same thing. Conversely, having too few entities will not fully identify the system elements (Vaneman, et al., 2022). These entities become the essential elements of information that describe the system.

In addition to the foundational list of entities, the ontology should also define the relationships and attributes of those entities. A common way to describe an ontology is with entities, relationships, and attributes (ERA). The entity (i.e., the nouns in the ontology) defines the system's elements that it seeks to portray. A relationship (i.e., the verbs of an ontology) connects entities to each other through standardized terms. An attribute (i.e., the adjectives of an ontology) is the inherent characteristic or quality of an entity. It further describes the entity, enhancing its uniqueness. A final critical ontology element comes in the form of attributes on relationships (i.e., the adverbs in an ontology). These attributes do not define the structure of the model but enrich it by qualifying how, when, or under what conditions a relationship occurs (LMO, 2025).

The Lifecycle Modeling Language Version 2.0 (LML 2.0) adheres to the economy of entities principle with 24 total entities (12 parent entities, 12 child entities), and their defined relationships and attributes, thus making it well-suited to serve as the foundational schema for the ASoT (Lifecycle Modeling Organization, 2025). Table 1 is a summary of common LML Entity Classes (LMO, 2025).

The relationships and their attributes within the ontology allow for the complexity of the system to be

represented in a model (i.e., a virtual representation of the system) even when an economy of entities approach is used. The defined relationships between entities further apply to the sub-entities through the principle of inheritance.

The relationship matrix in Figure 2 shows the 12 primary entities of the ontology and their relationship to each other (LMO, 2025). Each entity has one-to-many or many-to-many, possible relationships within the matrix. For the 24 LML 2.0 defined entities, the total possible combinations is not 24^2 or *576* combinations but approaches *24!* or 6.21×10^{23} combinations. This phenomenon allows the complexity of the system to be modeled while having a manageable entity and relationship "vocabulary" at the atomic level. This allows for the commonality among various organizations, different modeling languages, and tools.

Table 1. Summary of Common LML Entity Classes (LMO, 2025).

Entity	Definition	Examples
Action	An **Action** entity specifies the mechanism by which inputs are transformed into outputs.	Activity, Capability, Function
Artifact	An **Artifact** entity specifies a document or other source of information that is referenced by or generated in the knowledge base.	Policy, Guidance, Governance, Standard
Asset **(Resource)**	An **Asset** entity specifies an object, person, or organization that performs Actions, such as a system, subsystem, component, or element. A **Resource** sub-entity specifies a consumable or producible Asset.	Platform, System, Service People, Fuel, Supplies
Characteristic **(Measure)**	A **Characteristic** entity specifies properties of an entity. A **Measure** sub-entity specifies properties of measurements and measuring methodologies, including metrics.	"Ilities" –Adaptability, Reliability, Maintainability Measure of Effectiveness (MOE), Measure of Performance (MOP),
Connection **(Conduit)** **(Input/Output)**	A **Connection** entity specifies the means for relating Asset instances to each other. A **Conduit** sub-entity specifies the means for physically transporting Input/Output entities between Asset entities. It has limitations (attributes) of capability and latency. An **Input/Output** sub-entity specifies the information, data, or object input to, trigger, or output from an Action.	 Conduit, Interface, Data Link, Pipe Data, Information, Energy, Trigger
Cost	A **Cost** entity specifies the outlay or expenditure (as of effort or sacrifice) made to achieve an objective associated with another entity.	Actual Cost, Planned Cost, Total Cost
Decision	A **Decision** entity specifies a challenge and its resolution.	Major Decision, Problem, Resolution, Challenge, Issue
Location **(Physical)** **(Orbital)** **(Virtual)**	A **Location** entity specifies where an entity resides. A **Physical** sub-entity specifies a location on, above, or below the surface. An **Orbital** sub-entity specifies a location along an orbit around a celestial body. A **Virtual** sub-entity specifies a location within a digital network.	 Geospatial coordinates Ephemeris. Orbit URL
Risk	A **Risk** entity specifies the combined probability and consequence of achieving objectives.	Cost Risk, Schedule Risk, Technical Performance Risk
Statement **(Requirement)**	A **Statement** entity specifies text referenced by the knowledge base and usually contained in an Artifact	Need, Goal, Objective, Assumption Functional Requirement, Performance Requirement, Safety Requirement

	A **Requirement** sub-entity identifies a capability, characteristic, or quality factor of a system that must exist for the system to have value and utility to the user.	
Time	A **Time** entity specifies a point or period when something occurs or during which an action, asset, process, or condition exists or continues.	Phase, Milestone, Chronological

	Action	Artifact	Asset (Resource)	Characteristic (Measure)	Connection (Conduit, Logical)	Cost	Decision	Input/Output	Location (Orbital, Physical, Virtual)	Risk	Statement (Requirement)	Time
Action	decomposed by* related to*	references	(consumes) performed by (produces) (seizes)	specified by	-	incurs	enables results in	generates receives	located at	causes mitigates resolves	(satisfies) traced from (verifies)	occurs
Artifact	referenced by	decomposed by* related to*	referenced by	referenced by specified by	defines protocol for referenced by	incurs referenced by	enables referenced by results in	referenced by	located at	causes mitigates referenced by resolves	referenced by (satisfies) source of traced from (verifies)	occurs
Asset (Resource)	(consumed by) performs (produced by) (seized by)	references	decomposed by* orbited by* related to*	specified by	connected by	incurs	enables made responds to results in	-	located at	causes mitigates resolves	(satisfies) traced from (verifies)	occurs
Characteristic (Measure)	specifies	references specifies	specifies	decomposed by* related to* specified by*	specifies	incurs specifies	enables results in specifies	specifies	located at specifies	causes mitigates resolves specifies	(satisfies) spacifies traced from (verifies)	occurs specifies
Connection (Conduit, Logical)	-	defined protocol by references	connects to	specified by	decomposed by* joined by* related to*	incurs	enables results in	transfers	located at	causes mitigates resolves	(satisfies) traced from (verifies)	occurs
Cost	incurred by	incurred by references	incurred by	incurred by specified by	incurred by	decomposed by* related to*	enables incurred by results in	incurred by	located at	causes incurred by mitigates resolves	incurred by (satisfies) traced from (verifies)	occurs
Decision	enabled by result of	enabled by references result of	enabled by made by responded by result of	enabled by result of specified by	enabled by result of	enabled by incurs result of	decomposed by* related to*	enabled by result of	located at	causes enabled by mitigated by result of resolves	alternative enabled by traced from result of	date resolved by decision due occurs
Input/Output	generated by received by	references	-	specified by	transferred by	incurs	enables results in	decomposed by* related to*	located at	causes mitigates resolves	(satisfies) traced from (verifies)	occurs
Location (Orbital, Physical, Logical)	locates	locates	locates	locates specified by	locates	locates	locates	locates	decomposed by* related to*	locates mitigates	locates (satisfies) traced from (verifies)	occurs
Risk	caused by mitigated by resolved by	caused by mitigated by references resolved by	caused by mitigated by resolved by	caused by mitigated by resolved by specified by	caused by mitigated by resolved by	caused by incurs mitigated by resolved by	caused by enables mitigated by results in resolved by	caused by mitigated by resolved by	located at mitigated by	caused by* decomposed by* related to* resolved by*	caused by mitigated by resolved by	occurs mitigated by
Statement (Requirement)	(satisfied by) traced to (verified by)	references (satisfied by) sourced by traced to (verified by)	(satisfied by) traced to (verified by)	(satisfied by) specified by traced to (verified by)	(satisfied by) traced to (verified by)	incurs (satisfied by) traced to (verified by)	alternative of enables traced to results in	(satisfied by) traced to (verified by)	located at (satisfied by) traced to (verified by)	causes mitigates resolves	decomposed by* traced to* related to*	occurs (satisfied by) (verified by)
Time	occurred by	occurred by	occurred by	occurred by specified by	occurred by	occurred by	date resolves decided by occurred by	occurred by	occurred by	occurred by mitigates	occurred by (satisfies) (verifies)	decomposed by* related to*

Figure 2. LML Relationship Matrix (LMO, 2025).

The total possible relationships shown in Figure 2 can be overwhelming, since no single system is going to use the entire set of 6.21×10^{23} combinations. The ontology informs the creation of the Conceptual Data Model (CDM), which serves as a system-specific subset containing all relevant entities, relationships, and attributes. The CDM acts as the system's meta-model, mapping modeling languages and tools used to represent different system aspects, and highlighting where data exchange and integration are needed for the system's virtual representation. Within a DDE ecosystem, the CDM facilitates the structured planning of data development while ensuring the integrity of the underlying ontology is preserved. Figure 3 is a notional CDM.

Finally, Protégé OWL (Web Ontology Language) can govern and manage the ASoT by using ontologies to define a formal, consistent, and shared conceptual model of a domain. OWL allows for clear definitions of entities, relationships, and constraints, ensuring data and knowledge follow a consistent and unified semantic structure. This ontology-driven approach ensures that all data adheres to a shared conceptual model, reducing ambiguity and enhancing interoperability.

NOTE: In an ontology, constraints define the rules and limitations that govern how entities and relationships can be used. They ensure logical consistency, enforce business rules, and guide reasoning. While attributes on relationships are not constraints themselves, they can be used to express or support constraints.

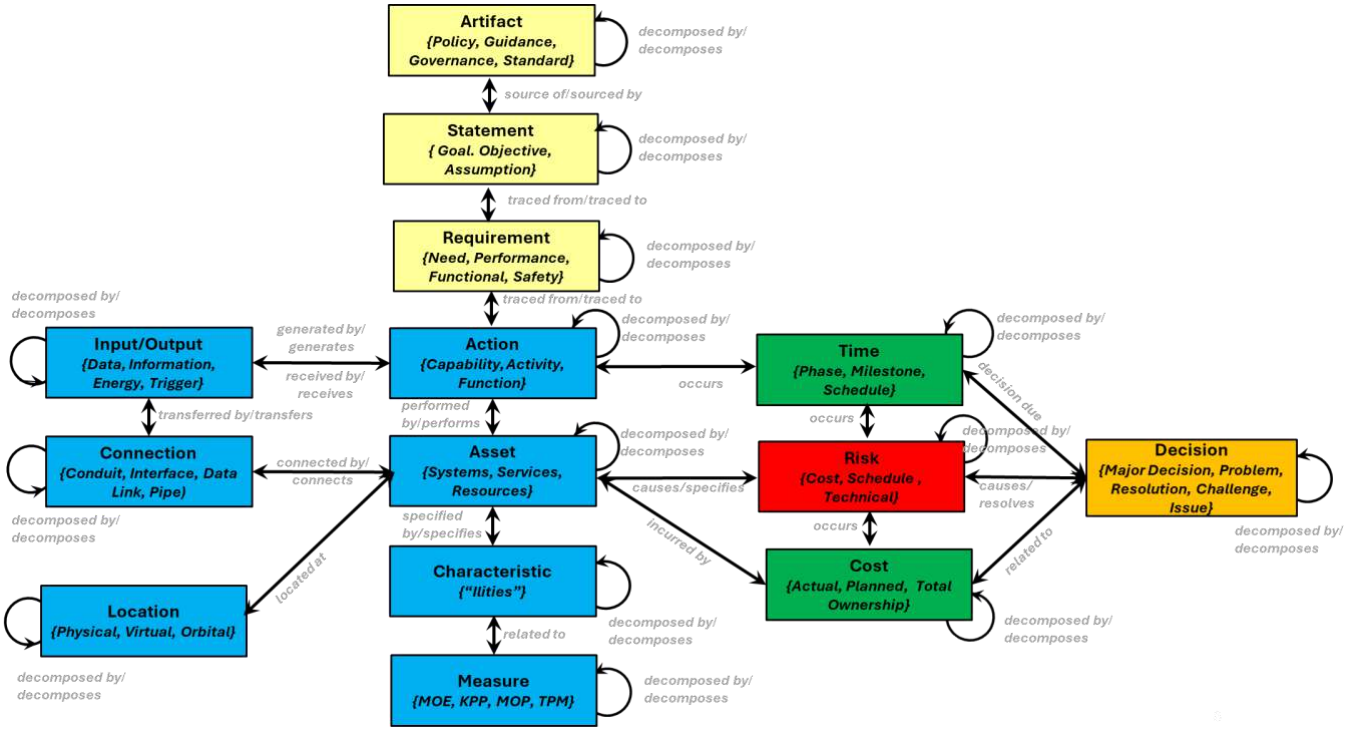


Figure 3. Notional CDM.

Data Integration

Data integration is a continuous process of combining data from multiple sources to create a unified view, aiming to provide a holistic and consistent dataset for analysis and decision-making. Since DDE involves data, large datasets, and multiple datasets to represent the system, its concepts can be aligned with the principles and properties of set theory.

Set theory supports data sharing by providing a structured framework for organizing, comparing, and manipulating datasets. The features of set theory that are applicable to DDE are:

- **Mathematical Foundation** - Provides a rigorous mathematical framework that can be used to prove properties about the data and ensure the correctness of data sharing processes.
- **Data Consistency** - Ensure that data remains consistent across different systems by defining clear rules for set membership, how uniformity is maintained, and how data is represented and shared.
- **Data Integration** - Provides a mathematical foundation for combining data from different sources. By defining data as sets, operations such as union, intersection, and difference to integrate and compare datasets effectively.
- **Scalability** - Allows for the handling of large and complex datasets efficiently. This scalability is crucial for data sharing in environments with vast amounts of information, such as big data applications.

Wymore first applied set theory in his 1993 book, "Model-Based Systems Engineering." It emphasized the use of formal modeling methods, including a mathematical foundation, to design and analyze complex systems. While visionary, the book did not gain widespread popularity in the Systems Engineering Community due to the focus on document-based systems engineering and an immature MBSE concept (Wach et al., 2021). With the current focus of systems engineering on data derived from models, an ASoT, and data integration, the time is ripe for the systems engineering community to revisit how set theory can be applied.

A mathematical treatment of set theory is not included in this paper; however, a non-mathematical discussion is provided to illustrate how set theory principles and processes relate to the LML ontology and how they can be used to verify the system model.

The ontology represents the universal set as it contains all possible entities, relationships, and attributes within a particular domain of the system. Each entity within the ontology is a class, which allows the entities to the categorized within the system structure. The CDM is a subset of the ontology, and the taxonomy principle defines how the system is organized hierarchically. The data type property and annotated property are applied to the attributes. The data type property describes attributes that represent literal data (e.g., numbers, Boolean, datetimes, percent), while the annotated property attributes convey additional information about the entities (e.g., text, URI, enumeration) (Downing, 1995; Horridge, et al., 2004; Vaneman, et al., 2023).

Protégé OWL uses set theory as the foundation of how it models data structures with ontologies. It enables formal verification of system models with mathematical reasoning about the entities, relationships, and constraints. Verification involves checking consistency, completeness, and correctness by ensuring that elements belong to appropriate sets and that hierarchical relationships hold. This mathematical foundation enhances model verification, error detection, and logical inference in complex system architectures. Table 2 provides a non-mathematical mapping of the set theory properties, common LML relationships, and the logical constructs that are verified.

Table 2. Mapping Set Theory Properties, LML Relationships, and Verifications.

Property	Common LML Relationships	Verifies
Object Property - Establishes relationships between entities.	- Any LML relationship that connects two entities	- Relationship Validity - Traceability
Inverse Property – For every entity that has an operation, there exists an inverse operation that can undue it and return it to its original state.	- Causes/Caused by - Consumes/Consumed by - Decomposes/Decomposed by - Enables/Enabled by - Performs/Performs by	- Bidirectional Relationships - Symmetric Operations
Functional Property – Each input can have an output.	- Caused by - Decomposed by - Mitigated by (for one-to-one mapping) - Performed by (for one-to-one mapping)	- Deterministic behavior - Unique assignments - Constraint enforcement
Inverse Functional Property - Each output can have exactly one input.	- Caused by - Decomposed by - Mitigated by (for one-to-one mapping) - Performed by (for one-to-one mapping)	- Uniqueness of identifiers - One-to-one mapping - Dupliocate or conflicting associations

Transitive Property – If entity *a* is related to entity *b*, and also entity *b* to related to entity *c*, then it can be inferred that entity *a* is related to entity *c*.	- Decomposes - Related to	- Hierarchical structures - Part-whole relationships - Causal or temporal dependencies
Symmetric Property – If entity *a* is related to entity *b*, then entity *b* is related to entity *a* in the same way.	- Related to	- Bidirectional relationships - Undirected connections - Symmetric dependencies
Asymmetric Property – if entity *a* is related to entity *b,* then entity *b* cannot be related to entity *a*.	- Causes - Consumes - Decomposes - Performs	- Undirected relationships - Irreversible processes - Causal dependencies
Reflexive Property – Every object is an entity *a* to itself.	- Connected to - Related to	- Equivalence relationships
Irreflexive Property – No entity is related to itself.	- Causes - Decomposes - Produces	- No self-dependency - Strict ordering - Causal and temporal constraints

A common view of data integration in an ASoT is shown in Figure 4. E_x represents an entity (e.g., System Component) that is common to all models and serves as the focal point for combining the data into a single data set within the ASoT. This assumes that $E_{x1} = E_{x2} = E_{x3}$. While this approach may work for data sets that are fully compliant with a common modeling language and tool, combining data in an ASoT is more complicated than meets the eye.

While E_x appears to be the same in each data set, there are several differences that make data integration a challenging problem. The challenges include ensuring data accuracy, achieving data consistency while integrating diverse data sources generated from disparate modeling languages and formats, traceability of data models and tools, and governance, management, and security.

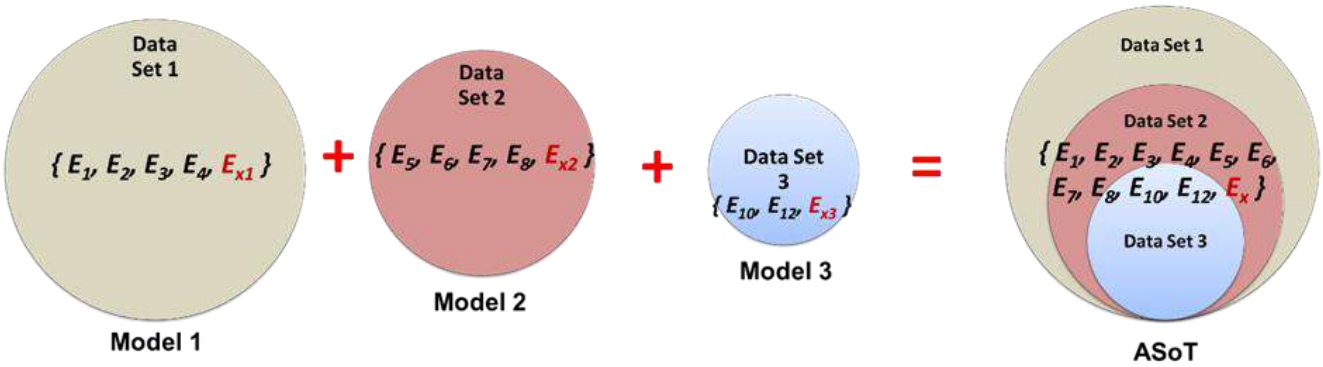


Figure 4. Common View of Data Integration in an ASoT.

A more realistic approach to data integration in an ASoT is depicted in Figure 5. In this scenario:

Data Integration = f{Entities, Structure and Relationships (r), Attributes (a), Modeling Languages (l), Data Format (f), Data Fidelity (fi), Data Consistency (c), Data Security (s)}.

In reality, $E_{x1(r,a,l,f,fi,c,s)} \approx E_{x2(r,a,l,f,fi,c,s)} \approx E_{x3(r,a,l,f,fi,c,s)}$. For this multi-dimensional problem, data integration in an ASoT presents challenges related to combinatorial complexity, as well as potential issues with

dynamic complexity. A well-defined problem sets the stage for developing efficient solutions, particularly in combinatorial problems where the potential solution space can be vast.

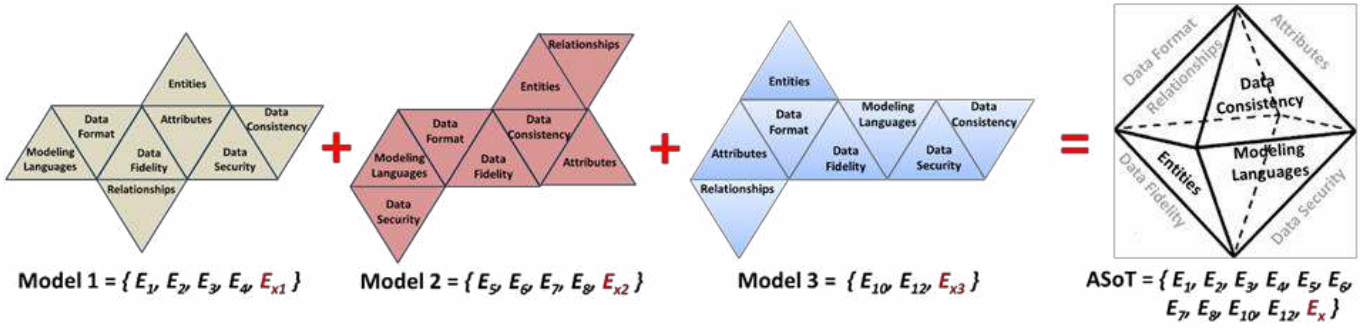


Figure 5. Realistic View of Data Integration in an ASoT.

Given the potential complexity of data integration, Artificial Intelligence (AI) must be used as an enabler. Embedded AI-enabled analytics continuously extract actionable insights and support informed, timely decision-making by leveraging a suite of advanced capabilities. Through automated data mapping and schema matching, disparate data sources are harmonized efficiently, while ontology alignment and semantic integration ensure contextual consistency across domains. Data cleansing and quality improvement processes enhance the reliability of inputs, enabling more accurate analysis. Simultaneously, real-time data fusion aggregates and synchronizes information streams, providing a unified view of operations. These insights are further refined by AI-driven decision support systems, which offer predictive and prescriptive recommendations. Finally, adaptive integration via continuous learning allows the system to evolve dynamically, improving performance and relevance over time.

To be effective, we must understand that AI represents a paradigm shift and trust it as a strategic partner in managing data integration within the ASoT. AI capabilities can streamline complex data ecosystems, enhance semantic alignment, and enable real-time, intelligent decision-making - transforming how data is unified, interpreted, and acted upon. AI shifts integration from brittle, rule-based processes to a dynamic, learning-driven capability. The importance of AI will grow as the DDE ecosystem is expanded across the entire system's lifecycle.

The Data-Driven Spectrum

The Data-Driven Spectrum is a structured and continuous framework that describes how data in a digital thread is collected, managed, integrated, analyzed, and used across the entire system lifecycle - from concept development through disposal. This spectrum enables decision-makers, engineers, and stakeholders to leverage increasingly rich, interconnected data streams to inform decisions throughout all phases of the system's lifecycle. Key characteristics of the spectrum include:

- **Lifecycle-Spanning Integration** - Connecting data from early requirements and concept exploration through operations and disposal.
- **Progressive Data Fidelity** - Increasing precision, volume, and integration of data as the system matures.
- **Model-Based and AI-Enabled Analytics** - Embedding models and advanced analytics to continuously extract insight and support informed, timely decision-making.
- **Feedback Loops** - Utilizing operational and sustainment data to inform future system upgrades, maintenance planning, and new system concepts.

The Data-Driven Spectrum is a range of distinct but related models and data that are arranged in progression. While the same ontology - entities, relationships, and attributes – are used throughout the spectrum, the models that are used to analyze and visualize the spectrum change as the system lifecycle changes, thereby continuously increasing the data needs, resulting in a data flywheel effect. The Data-Driven Flywheel Effect is the process by which the data that accumulates compounds over time through continuous engineering activities during a system's lifecycle. As more data is collected and developed, better analysis can be performed, yielding insights that enable data-driven decisions, which stimulate system design and operations improvements.

> *NOTE: In contrast to a spectrum where the same system is being described through different means throughout the system's lifecycle, a continuum emphasizes smooth, gradual transitions without clear boundaries between phases. For example, sound volume and intensity seamlessly flow where one state blends into the next, such that the sound itself does not change, but the volume and intensity do.*

Figure 6 depicts the Data-Driven Spectrum of data throughout the system lifecycle, beginning with conceptual diagrams that capture high-level ideas and stakeholder needs. These evolve into a capability architecture, defining what the system must achieve, followed by a functional architecture that outlines how those capabilities will be realized through specific functions. This leads to system architecture, where functions are allocated to physical and logical components. As the design matures, computer-aided design (CAD) tools are used to create detailed geometric models representing the physical architecture, which feed into the test architecture to validate performance against requirements. The integration of architecture then ensures that all components work together seamlessly. Ultimately, as this data converges into a comprehensive digital twin - a dynamic, real-time virtual representation of the system that supports monitoring, optimization, and decision-making from development through operation and eventual disposal. This spectrum ensures that data remains consistent, traceable, and actionable across every phase of the lifecycle.

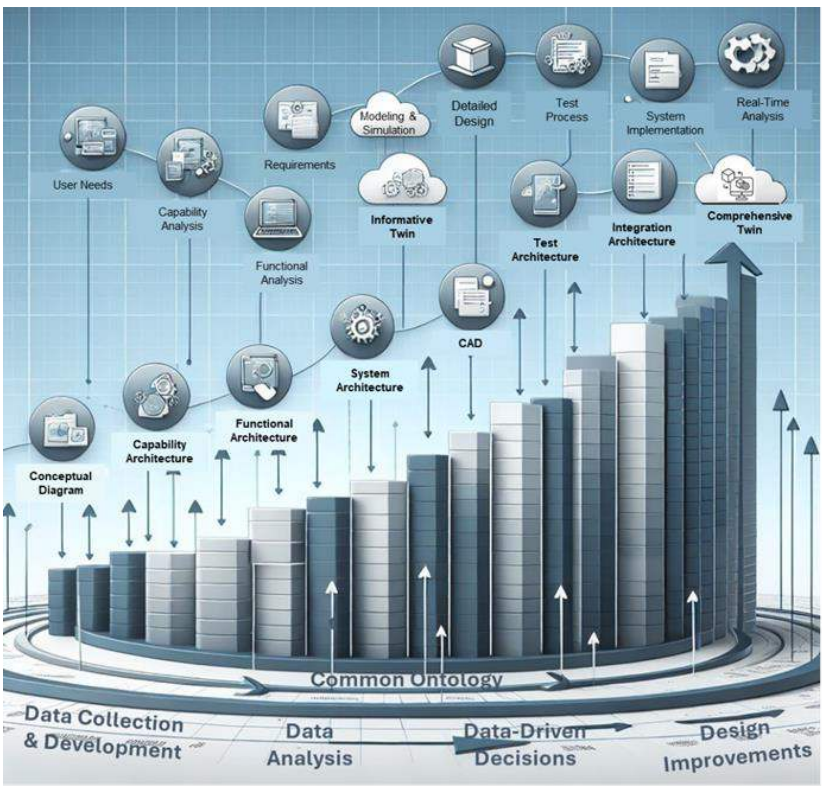


Figure 6. The Data-Drive Spectrum.

Conclusion

Establishing an ASoT within a DDE ecosystem is not merely a technical challenge - it is a paradigm shift in how systems are conceived, modeled, and managed. This paper has shown that achieving a trusted ASoT requires more than integrating digital artifacts; it demands a foundational ontology, semantic alignment, and a commitment to data concordance. The coupling of LML and set theory provides the structural and logical rigor necessary to support this transformation. Embedded AI capabilities further enhance the ASoT by enabling real-time data fusion, adaptive learning, and intelligent decision support. As systems grow in complexity and scale, the ASoT becomes essential for maintaining traceability, consistency, and trust across the lifecycle. The Data-Driven Spectrum illustrates how data evolves into a dynamic digital twin, enabling continuous insight and improvement. Ultimately, embracing a data-centric, AI-enabled approach to systems engineering will empower organizations to manage complexity, reduce risk, and make more informed decisions throughout the system's lifecycle.

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About the Author

Dr. Warren Vaneman is a retired Professor of Practice from the Systems Engineering Department at the Naval Postgraduate School, where he played a pivotal role in advancing systems engineering research and education and mentoring future leaders. He brings four decades of leadership and systems engineering experience from distinguished roles within the Intelligence Community and Department of Defense.

A highly decorated Navy Reserve Captain, he holds a BS from State University of New York Maritime College, an MS in Systems Engineering, and a Ph.D. in Industrial and Systems Engineering from Virginia Tech. He is also a long-standing adjunct professor at Virginia Tech and an INCOSE-certified Expert Systems Engineering Professional (ESEP).

"

I have been impressed with the urgency of doing. Knowing is not enough; we must apply. Being willing is not enough; we must do.

Leonardo da Vinci

Impressions From INCOSE IS2025 in Ottawa

By Richard Beasley and John Fitch

Project Performance International

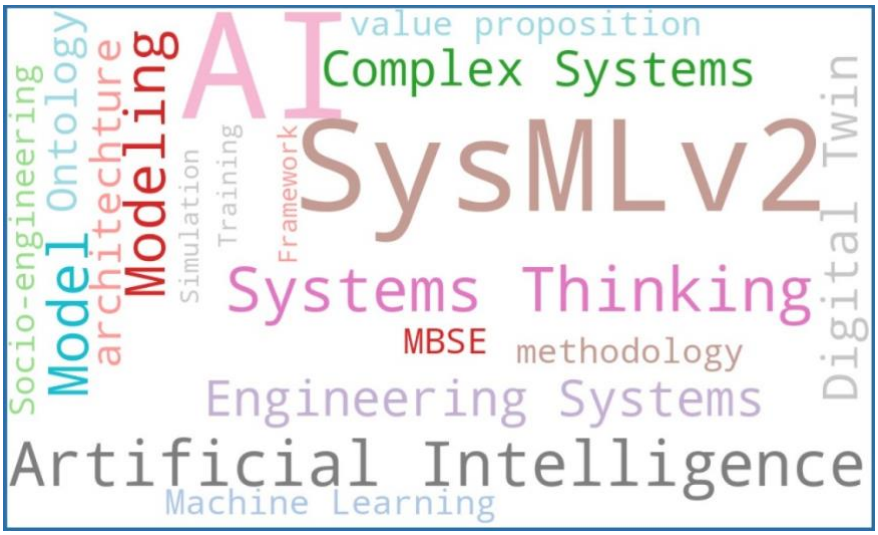
Authored for PPI SyEN

Richard Beasley Impressions

The INCOSE International Symposium was held between 26th - 31st July 2025 in Ottawa, Ontario, Canada. At the start, the announced attendance was a total of 856 registrations – 667 in-person and 189 online (that number may have increased during the event). The agenda was as full as always – in total there were approximately 16 tutorials (held at the weekend), approximately 22 working group meetings, 12 business meetings; 4 keynote presentations, and (spread across 7 tracks) a total of 100 paper presentations (81 in person, 10 hybrid, 9 virtual only), 56 presentations without a paper (36 in person, 17 hybrid, 3 virtual only), 6 panels (3 in person, 3 hybrid) and 20 hybrid sponsor presentation. So there was a wide range of material (a total of 186 sessions) and every attendee probably chose a different set of material (I attended 30 sessions, so only approximately 16% of the available material) – this report reflects my experience.

The range of content is exemplified by the themes of the opening and closing keynotes – the impact of AI versus the importance of human factors and systems thinking. The first keynote painted a futurist's vision of the impact of Artificial Intelligence (AI) on the practice of Systems Engineering (SE). Depending on your point of view, this will either be exciting with a profound improvement and better practice of SE or terrifying as the AI becomes hugely more intelligent than humans (there are already reports of AI systems hiding their full capability when being tested). Whatever your point of view, there will certainly be a significant impact and soon, based on the huge investments. Amazon, Meta, Google and Microsoft are between them investing ~$160 billion in AI in 2025 alone, and it is predicted

that in the next decade there will be 100 times more AI robots than humans. The impact of AI will be across all aspects of SE, and it will be soon – the speaker suggested that we have 18 months to understand the impact. In contrast, the final keynote focused on Systems Thinking and the importance of managing/understanding the Human Factors involved in the development and use of systems. The challenges facing the world, with "wicked" problems (with interconnectedness, conflicting goals, uncertainty, and lack of a clear definition of the problem), need this approach, but there is a challenge in both human behaviors and the engagement with the systems approach. There is an almost philosophical approach to address the idea (from Donella Meadows) that there are no boundaries / separate systems, and the need to divide the system into parts to enable practical work, leading to optimization of the parts (the idea of Boundary Rationality from Herbert Simon). So full systems leadership needs us to engage fully, not just with tools and data.
Topics at the IS are summarized by the attached word cloud (taken from the book of abstracts).



My personal feeling is that this is quite balanced – the material on people development, organizations and culture had a broader range of words. The themes I saw covered the following:

Application of Artificial Intelligence
Obviously (given the first keynote!), there was a lot of discussion of this topic. My impression (compared to previous conferences) was that there was a greater emphasis on AI for SE rather than the SE of AI in products. At least the AI can take the "drudgery" out of elements of analysis, see the patterns implicit in the problems and solutions, and ensure consistency. The most important issue was addressing the validity of the AI inputs to the system development – there needs to be careful consideration of what input the AI used, and how the questions were posed. Certainly, AI will be a significant improvement to the efficiency of SE practice – the question is to what extent it will make it more effective.

MBSE, SysML (V2), Analysis and Simulation
The biggest theme, beyond the embedding of AI into the tools and methods described above, is the advent of SysML V2.0. Beyond that, there was an extensive description of advances in the ability to analyze and simulate. A concern for me (listening to others) was that there appeared to be an over-emphasis on the technique development to the solution side of the lifecycle, and less on the problem understanding. The third keynote speech from an astronaut dramatically and powerfully demonstrated the importance of simulation in mission preparation and crew training. As the INCOSE President put it, there is more to MBSE than SysML, more to modeling and analysis than MBSE, and more to Systems Engineering than just MBSE.

Descriptions of Practice

Material covered all aspects of the lifecycle, from early concept (R&T), problem exploration, early concepts, architecture, verification/validation and maintenance, upgrade in service, and the management of data/configuration. The impact of improved methods and digital threads was extensively discussed. This set of material, as a whole, emphasized the ubiquity of the applicability of the Systems Approach across the whole lifecycle and multiple domains.

People, Roles, and Culture

As chair of the Embedding Systems Engineering into Organizations working group, this topic was my main interest. One keynote described the importance of applying SE to the organization – to create a system that "can create products that can be modified, updated, improved". 29 years after the original "12 Systems Engineering roles", Sarah Sheard updated this oft-cited paper with "Systems Engineering roles with a new era". There was discussion on certification, how SE skill is developed, and how expertise is achieved. There were descriptions of Systems Thinking and Engineering as an "art", and a fascinating examination of Western and Eastern cultural perspectives on the application and practice of Systems Engineering.

It is important to recognize that the participants and the material presented did not speak with one unified voice. That is a good thing, not a criticism. The diversity of views gives a deeper insight. There were some things said that, on first impression, I disagreed with profoundly. In some cases, it was a case where the application of SE was in a totally different domain from my experience, but more often it was a different viewpoint/perception. A short reflection deepened my understanding by seeing the different points of view. Systems Engineering needs to be comfortable seeing things from multiple perspectives (of the same thing), and that comfort needs to extend to different perspectives of Systems Engineering practice.

In conclusion, the overall impression I got was that a systems engineering approach (of whatever flavor) is increasingly relevant and needs urgent and effective application in almost every "engineered" domain. However, it is clear that there is no common acceptance or understanding of what SE actually is. Those in the Systems Engineering community cannot wait for the world to come calling - and must not arrogantly present a fixed (and inaccessible practice). INCOSE is in a position to be the "authority" for Systems Engineering – but that must be in a way that communicates clearly and empathizes with the situation, so that the approach can be valued, understood, and embraced. Membership in the World Federation of Engineering Organizations (WFEO) presents a new opportunity. The biggest problems in the world are not technological but systemic. Effective application of systems approaches can "enable a better world". This makes the ideas expressed at this Symposium of extreme importance.

John Fitch Impressions

I experienced IS2025 mostly from interactions with visitors to the Exhibition Hall in general, visitors to the PPI booth in particular (thanks to all who stopped by and even more to those who lingered for deeper discussions), plus through numerous, often vigorous conversations with the other exhibitors that were there vying for share of mind (and eventually share of wallet) with the conference delegates. I came away with mixed signals concerning whether the systems engineering community, as represented at the INCOSE IS is experiencing convergence toward a common paradigm for 21st-century practice or a hardening into competing camps that will reach very different audiences among the millions of problem solvers and engineers around the globe. But I agree with my colleague, Richard Beasley, that "The diversity of views gives a deeper insight."

On a positive note, there appears to be almost universal agreement on the need for a common language that can richly express the problem domain and solution space for any situation. Everyone seemed to agree that a key to defining the problem to be solved and describing the solution to be created requires a way to structure information so that individual mental models can sufficiently converge into a common mental picture that can support efficient teamwork and stakeholder communication. Whether called an ontology, information architecture, information metamodel or schema, (See Dr. Warren Vaneman's article in this edition on the Authoritative Source of Truth for some distinctions between these constructs), this model balances the need for definitional rigor, consistency in meaning, and comprehensiveness to cover an appropriate information scope to support full system lifecycles, while striving for simplicity to encourage its widespread use.

Which modeling language?

While the recently approved SysML v2 standard has significant momentum as the modeling "language of choice" among Symposium delegates, there remains a firm, but polite debate concerning the standard's maturity, fitness for the broadest range of problem/solution types, and its readiness for large-scale use based on vendor progress in software implementations and the challenges of converting a huge backlog of SysML v1 or other models to the new specification.

Competing with SysML v2 are other standards-based languages and also vendor-proprietary information metamodels that are embedded in MBSE software tools. In the Exhibition Hall, the Lifecycle Modeling Language (LML) was one example of the former, while the models embedded in Vitech's mature GENESYS software and SpicySE's newer offering represent the latter (proprietary) type. Each of these languages appears to be simpler than SysML v2 to learn and use, while still providing excellent coverage of the system lifecycle.

Competing engineering paradigms – hype vs realistic projections?

While a great majority of Symposium participants would agree that capturing problem definitions and solution descriptions in the form of text documents (perhaps with a few static "hand-drawn" diagrams) is insufficiently rigorous for the development of a complex modern system, there were two general "camps" that support significantly different MBSE paradigms. These two "flavors of MBSE" included those who saw diagrams (with well-defined notations/syntax that communicate essential semantics) as elucidating and contributing to the quality of textual descriptions of a system across its lifecycle. Most of the MBSE work in the past two decades falls into this broad "Diagrams Add Value" category, whether using SysML v1, LML, or vendor-proprietary information structures.

New to the scene, tightly associated with SysML v2, and potentially disruptive is the "System as Code" engineering paradigm that views a textual description of the system in a rigorous language, commonly understood and interpreted by humans and machines alike, as the key to the future of engineering by offering improved efficiency and development speed (through extensive AI-enabled automation), vendor-independence, data transparency and reusability. A good summary of the System as Code approach may be found in this Sensmetry/Tom Sawyer Software webinar recording. While intrigued by the unique aspects of the System as Code paradigm, I'm appropriately skeptical of some of these claimed benefits as they currently lack broad independent evidence-based validation. But PPI SyEN hopes to have a feature article on this paradigm in our final 2025 edition that is due out in November, so stay tuned for more discussion and hopefully evidence.

After 30 years, I remain thoroughly disappointed in the language and tool gaps that overlook decisions as a first-order class of knowledge that should be central to MBSE. Decisions are the fundamental thinking that transforms a problem definition into a solution description in a way that

the logic behind the design can be effectively communicated, traced, and revisited in the face of the almost inevitable changes in stakeholder needs and/or solution effectiveness.

Who is the global audience of SE goodness? Where is there untapped potential?
Paradigm wars are fought and won (or lost) in the marketplace of ideas. No one has the authority or market power to dictate a singular approach to the engineering of systems. Solution developers across all industries make their choices on engineering methods, modeling languages, and tools based on their current priorities, constraints, and knowledge of potential solutions.

From a PPI perspective, the audience for the value created by systems engineering "done well" is many millions of individuals across the globe. A significant majority of degreed engineers might benefit greatly from the adoption of just 5% or 10% or 20% of the disciplines that make up a comprehensive systems engineering process. And problem definition, solution development, and lifecycle support of systems is not limited to individuals with engineering degrees; much innovation occurs in communities organized around disciplines such as Design Thinking, Agile, Lean, Business Analysis, Axiomatic Design, System Dynamics, or a variety of system simulation techniques.

To this author, these realities imply that the definition of "best paradigm/language/method/tool" will vary across these overlapping communities. It's unlikely that INCOSE's Vision 2035 will see a significant convergence towards one or two dominant approaches to the engineering of systems. It is more likely that new combinations of successful practices and enablers will emerge while exploiting the rapidly developing (though often over-hyped) capabilities of AI to aid in human understanding and creativity.

Look for future articles on the competing paradigms and solutions as the battle rages.

About the Authors

Richard Beasley is a Principal Consultant and Course Presenter for Project Performance International. He is a highly accomplished systems engineering expert with over 37 years of experience, including a distinguished career at Rolls-Royce, where he was recognized as an Associate Fellow in Systems Engineering. Throughout his tenure, Richard played a pivotal role in embedding and implementing systems engineering best practices across the organization, ensuring a structured and efficient approach to complex product development.

A strong advocate for systems thinking and engineering transformation, Richard specializes in embedding systems engineering into organizations to improve engineering processes, reduce rework, and increase project success rates. His expertise spans gas turbines, aerospace systems, engineering management, and systems architecture, with a focus on practical applications of systems engineering methodologies to enhance product lifecycle efficiency.

Richard has an extensive body of published work, with over 40 papers and articles covering a range of topics. Richard, an INCOSE Expert Systems Engineering Professional (ESEP), has been an active leader within INCOSE, serving as President of INCOSE UK (2014-2016), Director of Services for INCOSE (2022-2024), and currently as Chair of the INCOSE Working Group on Embedding Systems Engineering into Organizations.

FEATURE ARTICLE

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.

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SYSTEMS ENGINEERING RESOURCES

Useful artifacts to improve your SE effectiveness

Business Analysis (BA) Digest Q3 2025 Edition

Blackmetric Business Solutions, a UK-based training and consulting firm, publishes a quarterly Business Analysis (BA) Digest. In keeping with its theme as *your regular round of useful BA content*, the 65-page Q3 2025 edition addresses topics such as:

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Typical articles are a quick read at 2-4 pages in length.

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INCOSE INSIGHT Practitioners Magazine - May & July Editions

Two editions of INSIGHT, INCOSE's Practitioner Magazine, have been published by Wiley since our latest edition (May 2025) of PPI SyEN. Electronic subscriptions to INSIGHT are available as a member benefit to INCOSE members. Hard-copy subscriptions to INSIGHT are available for purchase by INCOSE members for one membership year and to the public.

The May 2025 edition (Volume 28, Issue 2) is unique in its focus on a single Special Feature article titled "The State of the Systems Engineering Discipline: A Longitudinal Analysis of INCOSE International Symposium Contributions (2012–2025)" which communicates the work of Christian Sprague, PhD, in synthesizing an evolutionary view of the Systems Engineering discipline.

Abstract:
This first-of-its-kind meta-analysis provides unprecedented insights into systems engineering's evolution through a comprehensive examination of fourteen years of INCOSE International Symposium contributions. By analyzing over 4,000 submissions from nearly 5,000 authors, this study delivers unique value through three interconnected analyses:

The Authors' Analysis reveals a distinctive "hourglass network" where 10% of contributors generate 43% of intellectual output, alongside a critical 94% first-year attrition rate. This social architecture illuminates both resilience mechanisms and vulnerability points within the knowledge ecosystem, offering stakeholders targeted intervention opportunities for community development.

The Topics Analysis documents the discipline's methodological transformation, quantifying the shift toward model-based systems engineering (MBSE), growing from 30% to 40% while revealing persistent knowledge gaps in theoretical foundations and empirical validation. The detailed taxonomic classification exposes high-value research frontiers at previously unidentified disciplinary intersections.

The Acceptance Analysis uncovers systematic patterns in knowledge validation, demonstrating how acceptance rates have tightened year-over-year (90% to 40%) while certain submission characteristics significantly impact outcomes. This evidence-based filter mechanism provides contributors with strategic insights for knowledge dissemination.

Through synthesizing these analyses, this research provides a cohesive portrait of a discipline at an inflection point - transitioning from practice-driven origins toward greater formalization. For INCOSE leadership, educators, and practitioners, these integrated insights enable data-driven strategies to strengthen community resilience, address knowledge gaps, and enhance systems engineering's capacity to tackle the increasingly complex sociotechnical challenges of the 21st century.

Download INSIGHT Volume 28, Issue 2 from the INCOSE iNet.
View this issue in the Wiley online library.

INSIGHT's July 2025 edition (Volume 28, Issue 3) follows a more traditional topical structure. The ten articles in this 68-page publication address the theme of *Staying Alive in a Hostile Predatory Environment – Systems Need Engineered with Attitude*.

Attitudes
Author: Rick Dove

Digital controls and internet connectivity have fostered a hostile, predatory environment for modern systems. Organized crime and nation-state interests are naturally compelled to exploit these readily accessible opportunities for financial and political advantages. Systems engineering is being called upon to reorient its priorities accordingly. INCOSE's Future of Systems Engineering (FuSE) to realize the Systems Engineering Vision 2035 has a security-focused activity exploring what this reorientation might be. This article shares some of that thinking, exposes some issues in need of more thinking, and suggests why and how all systems engineers could and should be part of this thinking.

Using Systems Thinking to Advance Security in the Future of Systems Engineering (FuSE), a Progress Report
Authors: Systems Security Working Group

The Security in the Future of Systems Engineering (FuSE) team has made significant progress since its launch to realize the INCOSE vision described in Systems Engineering Vision 2035 (INCOSE 2021). The output products to date promote improved systems engineering practices to achieve security as a foundational perspective. The systems thinkers on this team have performed a holistic analysis of current practices to expose existing anti-patterns and mental models that informed the transformation to future practices that can yield desired results and achieve the 2035 vision. Needs-oriented, loss-driven, capability-based analysis to define security strategies that become functional requirements promotes stakeholder alignment of the security vision and leads to effective security tactics and techniques that collectively achieve the security strategies. The result is a system that achieves functional perseverance in a hostile, predatory environment. The work products completed so far and those in progress reflect our efforts to transition practices to a future where our systems are designed to achieve and sustain security as an intentional capability of the system throughout its lifecycle.

Protecting Mission Critical Systems: The Need for a Shift in Culture, Strategy, and Process
Authors: Ron Ross and Kymie Tan

In contrast to the traditional compliance-based approach to protecting space systems using the NIST Risk Management Framework (RMF), a trustworthy, secure systems engineering approach as described in the NIST Special Publication 800-160 is proposed as a viable and effective alternative. This paper discusses the issues and concerns with the traditional approach to cybersecurity and how engineering-based approaches measurably improve security, allowing a greater return on investment for mission-critical operational environments like those that support space missions. The paper will show that there are several facets to the cybersecurity problem that go beyond the technical to include culture, process, and policy, and explain why a change in strategy and approach is necessary to address the modern, sophisticated cyber adversary operating in a world of highly complex and evolving systems. Insights from a project where an NIST SP 800-160-based engineering approach was applied to secure a space mission will be discussed. The early lessons not only illuminate the benefits of security systems engineering, but also the effect of culture, policy, and process on building resilience into mission-critical systems.

Guide to Security Needs and Requirements – Making Security a Functional Requirement
Author: Beth Wilson

The INCOSE Systems Security Working Group completed a 2-year project to create a Guide to Security Needs and Requirements targeting both the systems engineering practitioner and the systems security practitioner to help them collaboratively define security needs and requirements that result in a secure system in operation. Starting with a set of anti-patterns for security requirements, we identified existing tactics that have not produced secure systems in the operational environment. The team then identified an approach to perform needs-oriented, loss-driven, capability-based analysis across the systems engineering activities. The result is a set of need statements capturing the stakeholder expectations concerning security and a set of functional requirements defining what the system must do to address those needs. Defining security as a functional requirement helps us design a system that can prepare for, defend against, and recover from adversity to achieve and sustain mission success.

Governance and Resilience: A Holistic Approach to Systems Security in Complex and Chaotic Environments
Authors: Sue Caskey and Adam Williams

A systems governance approach emphasizes a holistic perspective that identifies and navigates the interdependencies and conflicts between security and operational needs. Governance is defined as a collection of metasystems that provide the necessary constraints and processes to support, steer, adapt, transform, and sustain a system (Keating et al. 2022). Utilizing the Cynefin framework, which distinguishes between simple, complicated, complex, and chaotic environments (Snowden and Boone 2007), the article highlights the challenges faced by nuclear power plants in predatory contexts and the importance of integrating security objectives into governance frameworks.

By incorporating security as a fundamental aspect of governance, the article underscores its significance for persistence, adaptation, and transformation in the face of uncertainty. Additionally, it introduces key heuristics of systems security, such as the importance of context, knowledge-based decision-making, and organization-specific sociological factors (Williams and Caskey 2024). Ultimately, this work provides valuable insights into enhancing resilient operations in complex environments by reinforcing the connection between effective governance and security in systems engineering.

A Model-Based Approach for Privacy Risk Mitigation: Integrating Systems Engineering with System-Theoretic Process Analysis
Author: David Hetherington

Certain commercial operations, their systems, and their employees need to operate in hostile or semi-hostile environments. The physical environment may be challenging, but an unstable political/social environment often may be a greater challenge than any temperature or weather extremes. Such an unstable political environment may present rapidly changing threats to employee security. Even if local citizens in the immediate area are supportive, transnational violent gangs may be operating nearby. How do we design technology and human systems that can resiliently persevere in such an unstable environment?

In this article, we examine the design of a digital personal communications device designed to achieve these goals and demonstrate the use of System-Theoretic Process Analysis (STPA) to analyze a proposed design. Along the way, we will also demonstrate a model-based approach to the design work, which represents the recently released standard SAE J3307 “System Theoretic Process Analysis (STPA) Standard for All Industries” (J3307_202503, 2025), which specifies an auditable workflow for the STPA methodology described initially in the STPA Handbook.

How Security Needs Systems Engineering
Author: Mark W. Winstead

Peter Neumann once noted that complex systems are not like snapping Lego pieces together; rather, each piece added can transmogrify its modular interface and upset the existing structure. The effect for security can be a system weaker than its weakest link; moreover, addressing a security concern can disrupt achieving other emergent properties (e.g., safety). The article addresses these challenges by casting security as a system problem, where security engineering must not be done stove-piped from system engineering. The discussion within also addresses the role of systems thinking and the need for evidence-based assurance overseen by systems engineering.

Illuminating Systems Security Through Case Studies – Much More than Controls
Author: Beth Wilson

While systems security is a quality attribute (previously referred to as specialty engineering), learning

systems security is essential for all systems engineers. Learning about system security can be a challenge, especially when the focus is on security controls or identifying attack vectors. Case studies are a powerful way to see the real-world application of complex concepts. Reviewing cyber-attack case studies provides a captivating approach to examine security challenges and failures holistically using systems thinking, consider the technical concerns, business decisions, and human behaviors that made the attack possible, and explore systems security concepts from a systems engineering perspective.

When Malicious Actors Control Your Subsystems: A Systems Engineering Approach to Functional Perseverance
Authors: David Hetherington and Ivan Taylor

Security in modern engineered systems is not merely an added layer of protection but a prerequisite for system functionality. As systems engineers navigate the evolving security landscape, they must prioritize functional perseverance, the ability of a system to maintain operational integrity despite adversarial threats. This article examines a possible method for using system-theoretic process analysis (STPA) and system dynamics (SD) to enhance security-aware system engineering.

The approach shown is inspired by a 1982 paper called "The Byzantine Generals Problem" and is a peer-to-peer voting design that avoids single points of failure. In particular, we propose a system analysis and design approach that would allow the construction of a system capable of using peer-to-peer self-policing to detect an intruder that has already penetrated the security perimeter of the system and corrupted one or more of the subsystems. This article shows how STPA could inform the design of the peer-to-peer voting system and how SD could be used to examine the tradeoff of investments in redundancy versus the expected level of achieved resilience.

AI for System Security Design: A Good Tool or a Dangerous Weapon?
Author: Beth Wilson

As artificial intelligence (AI) tools have become more popular, industries wrestle with their effective use in the workplace. With promises of increasing efficiency and reducing complexity, it is tempting for systems engineers to use AI tools to quickly generate security requirements and skip engagement with systems security practitioners. The proliferation of AI tools that have been trained with security controls invites misguided approaches that deliver systems that are not secure in the operational environment. AI literacy is important to understand both the benefits and the limitations of AI to use it ethically and effectively.

Download INSIGHT Volume 28, Issue 3 from the INCOSE iNet.
View this issue in the Wiley online library.

INCOSE Systems Engineering Journal: May 2025 Edition

SYSTEMS ENGINEERING
The Journal of The International Council on Systems Engineering
INCOSE

INCOSE has published, through the Wiley online library, the May 2025 edition of the Systems Engineering Journal. Volume 28, Issue 3 includes both open-access articles, plus full-access papers

that require an institutional login, e.g., via INCOSE membership. There is no published overriding theme for this edition. PPI SyEN has included abstracts to guide our readers to which of these diverse topics best fit their interests.

Open Access Articles
Open Access articles are available to view and download in PDF format without any restrictions.

Hierarchical Planning Applied to the Preliminary Design of CubeSats: Nanospace Study
Authors: Thibault Gateau, Sophia Salas Cordero, and Rob Vingerhoeds

Abstract: CubeSat design has already been studied and formalized, but knowledge representation remains challenging. The management of human-learnt knowledge during the process is not an aspect that is often spoken about. This paper discusses the proposal of integrating a hierarchical planning approach with a model-based one into the open-source Nanospace framework, a web-based application for concurrent engineering during the preliminary design phase of CubeSats. Hierarchical planning aids in introducing commonly tacit human expertise, an aspect that the preliminary design of CubeSats can benefit from. The proposed integration could allow a faster design convergence and faster inspection of candidate architectures. The Nanospace framework itself may benefit from an approach that incorporates model-based efforts and hierarchical planning to facilitate knowledge representation and reuse. A use case on the CREME CubeSat project is detailed, emphasizing how to infuse the design iterations with experts' knowledge.

Navigating the Golden Triangle: The Need to Jointly Consider Modularization and Interface Choices When Making Performance, Cost, and Schedule Tradeoffs for Complex System Development
Authors: Taylan G. Topcu and Zoe Szajnfarber

Abstract: Decomposition is a critical enabler of complex system development, as it enables both task specialization and efficiency through parallel work. The process of decomposing involves partitioning system parameters into tightly coupled modules and managing any cross-module coupling by designing passive interfaces or through active coordination. A rich literature has developed algorithms and tools to support this process. However, we contend that this view has placed too much emphasis on module selection and not enough on the interaction with interface design. This perspective has significant implications for lifecycle costs and development time. To that end, this study explores how earlier consideration of interface design can create more valuable options better to navigate performance, cost, and schedule tradeoffs. Specifically, through an abstract simulation experiment, we demonstrate that (1) a sequential approach that first selects modules and then designs interfaces to support those modules, yields lower performance than an integrated approach that considers modules and supporting interfaces simultaneously; and (2) this result is even stronger when schedule and cost are considered as part of the evaluation. In other words, an integrated approach provides more options for project managers seeking to navigate the performance-cost-schedule tradeoff known as the golden triangle. These results emphasize the need for a decomposition aid that adopts a holistic view of the optimization problem, accounting for interface creation, intra-organization collaboration, and valuing nonperformance measures of effectiveness.

Risk Management for Commercial-Off-The-Shelf Parts-Based Space Hardware
Authors: Eric Herbert, Ronald Sega, Jeanne McGraw, and Thomas Bradley

Abstract: Commercial-Off-the-Shelf (COTS) parts use is a key strategy the space industry embraces to meet an ever-increasing demand for space access and services. Integrating COTS parts into spacecraft

architectures is beneficial in many aspects, such as integrating modern technologies, reducing costs, improving reliability, accelerating payload fielding, and alleviating supply chain constraints. As COTS parts become more prevalent in spacecraft designs, there is a need to update risk management techniques used in the industry. A COTS-centric risk management framework (RMF) does not exist, nor do space hardware standards and policies provide detailed guidance. To address this systems engineering gap, this research developed a novel RMF that can be employed to determine if candidate COTS parts are suitable for use in space hardware systems. The COTS parts RMF is a roadmap to identify uncertainties, analyze and evaluate the consequences, and mitigate COTS parts-based space system hardware risks. Additionally, to demonstrate its utility, the techniques were placed into practice and validated while developing a COTS-based space-rated battery built with COTS lithium-ion cells. The risk evaluation process, developed based on the proposed COTS part RMF, successfully uncovered and mitigated cell and battery material and design issues. This work significantly improved the battery's performance without hampering the project's schedule, cost, and fielding objectives. The results illustrate the characteristics and benefits of using a focused COTS parts RMF to design, build, and qualify COTS-based space system hardware.

Systems Engineering Methodology for Digital Supply Chain Business Models
Authors: Jochen Nuerk and František Dařena

Abstract: Globalization and growing business dynamics lead to weakly harmonized supply chain (SC) systems. While smart technology offers innovation opportunities, supply chains often lack the integration needed to leverage resources and collaboration fully. A comprehensive systems engineering (SE)-driven model for integrated innovation and optimization of smart SC business models is still missing. Through case research at SAP SE's Industry 4.0 division and three automotive companies, this study identifies key digital transformation objectives and interoperability gaps hindering smart opportunities. Systems engineering, supply chain management (SCM), and artificial intelligence (AI) methods were synthesized into a holistic SE-driven model for transforming and optimizing SC business models. This model integrates management concepts like the theory of ambidexterity and dynamic capabilities, with SE methods, capability engineering, complex adaptive systems, and semantic web concepts. Key SE contributions include meta-modeling multi-tier SC architectures, ensuring performance and resilience via simulations, and balancing value exploration and exploitation. Moreover, semantic harmonized and profit-optimized SC ecosystems enable collaborative innovation for flexible, efficient manufacturing—a core Industry 4.0 principle. This SE-driven model, validated by experts, provides a concise view of digital SC business models and drives generative design.

Using Concept of Operations to Design Human-Centric Manufacturing Systems for Novel Products - A Comprehensive Prescriptive Case Study
Authors: Malin Hane Hagström and Dag Bergsjö

Abstract: Efficient production systems are necessary for the realization of products that fulfill customer needs and delivery requirements. However, the process of designing the production system has received little academic attention, and today's manufacturing system design processes and architecture are still based on traditional engineering methods. This paper covers a case study using the systems engineering method, Concept of Operations and Operational Concept, to design a human-centric production system for a novel product. A comprehensive prescriptive study was designed, combined with attempts to verify the methods used. The case study applies design methods defined in ISO/IEC/IEEE 15288. A total of six workshops, the development of Concepts of Operations, three levels of Operational Concept, and two validation studies are documented. 166

persons participated, and up to 15 persons participated in the validation workshops. The analysis shows that the design methods addressed gaps identified in the literature: (1) the lack of systematic and effective systems engineering design methods in production system design, and (2) the lack of inclusion of human aspects in the production system design. The gaps in the effectiveness of the methods remain to be fully evaluated as the project is still running and will not be concluded until 2025. Recommendations for future work include exploring how the ConOps/OpsCon method can be more widely spread and adopted by engineering as a significant artifact for systems understanding for the design of more human-centric, resilient production systems.

Full Access Articles
Full Access articles are available through an institutional login, such as an INCOSE membership. This edition of the Journal includes the following titles:

- A Formal Metric to Measure Inconsistencies in Stakeholder Preferences in Systems Engineering
- Integrating axiomatic design and design structure matrix into model-based systems engineering: A case study for emergency response space mission design
- Mechanisms to support changeability during sustainment: Modularity, excess, and operations
- Storage Availability Prediction in Unmanned Aerial Vehicle Swarms Using Agent-Based Simulation
- What, When, Where, and How Many? A Systematic Review of Technical Measure Selection Guidance in Systems Engineering Literature

INCOSE members in good standing may access all Systems Engineering Journal content through their INCOSE Connect login (using the Wiley Online Proceedings Library link after login). Non-members may subscribe to the journal, use institutional logins from their university or place of employment, or purchase access to individual articles at the URLs associated with the article titles above.

System Dynamics Resources

The System Dynamics Society (SDS) hosts or recommends various system dynamics resources in the form of books, videos, blogs, webinars, and papers. Here are some recent open-access recommendations for your consideration.

The Connector – Spring 2025 Issue (isee systems journal)
Quarterly journal from the supplier of the Stella systems dynamics software, with articles such as:

- Steve Peterson uses Stella® to Speed the System Dynamics Learning Curve
- Generating Causal Loop Diagrams from Artificial Intelligence Engines

Systems Thinking and Its Relevance to Space Leadership (Recording)
Presentation to the African Space Leadership Institute (March 2025), introducing the fundamentals of systems thinking and demonstrating its strategic relevance to space leadership. Using a causal loop diagram to map key interdependencies shaping space programs' future and highlighting how feedback loops, leverage points, and systemic behaviours can inform better policy and mission design.

Introducing Feedback Thinking and System Dynamics Modeling in Economics Education (System Dynamics Review article)
This open-access paper discusses the opportunities and barriers for introducing feedback thinking and system dynamics models in the economics curriculum. Topics include:

- Pricing feedback model that illustrates some of the benefits of system dynamics
- Author experiences in teaching system dynamics in economics educational programs
- Different approaches to teaching economics with system dynamics
- Four-level course hierarchy for using system dynamics in economics teaching
- Tradeoffs to consider when introducing new pedagogies for delivering economics material

Strategizing towards the future hospital: a systems thinking approach (Journal paper)
The complex systemic nature of Future Hospital design in the rapidly ageing city-state of Singapore calls for systems thinking. We apply this approach to answer two research questions: (i) What variables drive the present and future dynamics of the Future Hospital system? (ii) How are these driving variables related?

Additional recommended open-access resources on system dynamics include:

- Designing Interface with Animation in Stella Architect (Workshop recording)
- Building a Leadership Reputation and Promotion Strategy Through Systems Thinking (Webinar recording)

Join the SDS to access numerous members-only resources.

OMG Journal of Innovation: Building Bridges of Security, Sovereignty and Trust in Business and Industry

The Object Management Group (OMG) published the 27th edition of its Journal of Innovation in May 2025. The theme of this edition is "*Building Bridges of Security, Sovereignty and Trust in Business and Industry*".

Articles to consider include:

A Cultural, Procedural, and Organizational Shift to Zero Trust
Emphasizes that successful Zero Trust implementation requires more than just technology - it demands a coordinated cultural, procedural, and leadership-driven transformation that prioritizes training, collaboration, and transparent communication.

Building Trust in the Security of Software
Outlines a multi-layered approach to software security - trusting the process, the developers, and the code itself - emphasizing the role of ISO/IEC 5055 and maturity models in identifying and mitigating severe software weaknesses.

Building Trust in Innovation Practices Through Innovation Frameworks and Risk Management
Presents a comprehensive innovation framework for risk-averse industries like aerospace and defense, emphasizing the need to balance security with experimentation through structured processes, resource planning, cultural alignment, and reframed risk tolerance.

SYSTEMS ENGINEERING RESOURCES

Integrity and Transparency for Trustworthy Supply Chain: Insights from Sustainability Regulations
Explores how emerging sustainability and labor regulations are driving the creation of interoperable supply chain data frameworks - like SBOMs, DPPs, and UNTP - with the potential to transform strategic planning through trustworthy, anonymized, and shared supply chain insights

Making the Case for Cybersecurity: Mending the Digital Thread with OMG Standards for Risk-Centric DevSecOps
Introduces a Risk-Centric DevSecOps framework that transforms cybersecurity into a continuous, model-driven reasoning process, leveraging OMG standards like SPECTRA to integrate system knowledge, threat intelligence, and assurance into automated pipelines.

Quantum Communications for Security and Quantum Computing
Advocates for a hybrid security model combining Quantum Key Distribution (QKD) and Post-Quantum Cryptography (PQC), demonstrating how QKD enables secure communications today and lays the groundwork for distributed quantum computing and future-proofed digital infrastructure.

The Tour d'Horizon of Data Law Implications of Digital Twins: Industry Implications
Analyzes the complex legal landscape surrounding digital twins, detailing privacy, data governance, and cross-border regulatory challenges across different industries and jurisdictions while offering compliance strategies for responsible DT deployment.

Threat Modeling Method for Digital Twins: Based on the DTC Platform Stack Architectural Framework
Presents a methodical threat modeling framework tailored to digital twin systems, using the DTC Platform Stack to identify assets, assess risks, and improve system trustworthiness across technology readiness levels.

Join the OMG mailing list.

Recommended Product Development and Innovation Resources

kHUB PDMA Knowledge Hub

The Product Development Management Association (PDMA) hosts a Knowledge Hub (kHUB) that offers various product development and innovation management resources in the form of blogs, podcasts, videos, conference presentations, feature articles, and whitepapers. Research articles from the Journal of Production Innovation Management (JPIM) are also included.

Recent recommendations include:

- 4 Keys to Strategic Storytelling that Drive Product Buy-In (article)
- Absorptive capacity in a more (or less) absorptive environment: A meta-analysis of contextual effects on firm innovation (JPIM article)
- Adopting Artificial Intelligence for New Product Development: The RAPID Process (article)
- A Framework for Understanding Emerging Consumer Needs (article)
- AI-Driven Product Strategy: Transforming the Future of Product Management (webcast)
- AI-PRISM: A New Lens for Predicting New Product Success (article)
- Aligning Product Portfolios with Strategic Plans (article)
- Carolinas Chapter Student Innovation Showcase (webcast)

- Debunking the Myths of Community-Driven Product Development (CDPD) (article)
- Direct and indirect effects of degree of interdisciplinarity on firms' innovation performance: The moderating role of firms' capabilities (JPIM article)
- Empathy-First Innovation: Integrating Patient Advocacy into Product Design (webcast)
- Engagement logics: How partners for sustainability-oriented innovation manage differences between organizational logics (JPIM article)
- From Concept to Market: Inside Food Product Development (article)
- Ideation Techniques: Conceptualizing New Products and Services (article)
- Let's Flow Ideation, Conceptualization, and Design Thinking in
- Product Design (article)
- Steve Jobs: A Product Developer's Perspective (article)
- Ten Tips to Create a Product Community of Practice (article)
- The Adoption and Performance Impact of AI in New Product Development: A Management Report (article)
- To Design Unique Concepts…Change your mindset! (blog + TEDTalks)
- Top management team attributes and corporate entrepreneurship: A meta-analysis (JPIM article)
- You're Not Just Shipping AI - You're Designing a Relationship (article)

Access to kHUB is free and open to the public. Full text access to JPIM research articles requires a PDMA membership or institutional access to the JPIM through the Wiley Online Library; however, kHUB publishes JPIM article abstracts and key takeaways.

Create a guest account or join PDMA here.

Why should Requirements Engineers care about GDPR?

Requirements Engineering Magazine
The Magazine for RE Professionals from IREB

The Requirements Engineering (RE) Magazine is published by the International Requirements Engineering Board (IREB) multiple times yearly. Articles are welcome from Business Analysis and Requirements Engineering professionals, regardless of IREB membership status. Publication is free of charge for the authors.

In the May 2025 edition, Guy Kindermans, Belgian IT Data News, authored an article titled "*Why and when must requirement engineers pay attention to the GDPR?*".

Overview:
Data, and in particular personal data, is the new gold, and with it comes the need for appropriate protection. The European General Data Protection Regulation (GDPR) is the 'gold standard' legal framework to ensure this protection.

Topics addressed include:

- GDPR – Why?
- GDPR – How?
- Role of Business Analysts and Requirement Engineers
- Common Effort

Read the full article here.

View the other 100+ RE Magazine articles.

Sign up to be notified about new issues of the Requirements Engineering Magazine.

See guidelines for contributing to the RE Magazine as an author.

MBSE-CON-2025 Videos

The Lifecycle Modeling Organization (LMO) develops and maintains an open-source modeling language that is structured and behavioral, the Lifecycle Modeling Language (LML). LML provides a simple way to understand and communicate cost, schedule, and performance design information to all stakeholders in a standard manner.

The LMO has posted on its YouTube Channel 15 videos containing 28 presentations that took place at the Model-Based Systems Engineering Conference (MBSE-CON 2025) in Orlando, Florida, USA from 23-24 April 2025.

The theme of this conference, "*Data-Driven Systems Engineering Enhanced by AI", is reflected in the video topics:*

- AI-Driven Bionic Agents to Enhance System Engineering User Experiences
- Application of AI-supported MBSE to Develop and Implement a System Requirements Review for a Satellite Mission
- Applying MBSE to AUVSI Events Using Innoslate
- Applying Systems Engineering Principles to the Lawmaking Process
- Best Practices and Lessons Learned from the Execution of Verification Activities
- Conjunctions: A Language-based Approach to Timing and Sequencing
- Data-Driven SE Enhanced by AI: Advancing MBSE With the Wind River Portfolio
- Document Parsing and Restructuring With AI Coding Assistant
- Enabling MBSE for SOPs Through Generative AI
- Enhancing Model-Based Systems Engineering With Augmented Reality
- Enhancing Multilingual Collaboration Using AI in the Systems Engineering Lifecycle
- Hum-AI-n in the Loop: Sociotechnical Systems Considerations for Leveraging the Use of AI to Enhance DDSE
- Innoslate Interoperability Using Data Mesh Technology
- Integrating Machine Learning Models Within a Systems Engineering Design in SysML for Predictive System Simulations
- Leveraging an Integrated Tool Ecosystem for DO-178C Compliance in Weapon System Design
- LML v2 Presentation (Detailed)
- LML v2 Update (Overview)
- ManTech's Smart Portfolio Solution (MSPS) for Optimizing and Modernizing Portfolio Management
- Marine Corps Command and Control Model Development With AI
- Practical Applications of AI to Enhance the Mission Engineering Process

- Revolutionizing System Requirements Management With AI
- Test Case AI on SPEC Innovations' Innoslate
- The Bionic Enterprise: Architecting the Intelligent Society of the Future (Keynote)
- The Challenges of Establishing an Authoritative Source of Truth for Data-Driven Systems Engineering
- The First Mile: Application of Agile Techniques to Develop and Organize Systems Engineering Artifacts to Enable Digital Implementation
- The Lifecycle Modeling Framework: Organizing and Simplifying the Application of Model-Based Systems Engineering
- Training the Aviation Subject Matter Expert Uninitiated in MBSE Using Fundamental Systems Engineering and AI
- Why Software Languages Fail to Support Systems Engineering

Note: Multiple presentations are captured in each video, but timestamps are provided to assist navigation.

AI-Assisted Model-Based Systems Engineering with SysML v2

Tom Sawyer Software has posted a May 2025 webinar featuring Tim Weilkiens, MBSE consultant, trainer, and CEO of oose, on *AI-Assisted Model-Based Systems Engineering with SysML v2*.

Abstract
Explore how artificial intelligence is transforming Model-Based Systems Engineering (MBSE) by adopting SysML v2. Learn how AI can assist with model creation, reduce manual effort, and improve consistency throughout your systems engineering workflow. This session includes practical insights and a live demonstration of AI-powered modeling in action. Don't miss the chance to hear directly from a lead developer of the SysML v2 standard and a recognized authority in model-based engineering. Topics addressed include:

- SysML v2 including its core principles, improvements over SysML v1, and its role in modern systems engineering
- How AI can assist MBSE
- Examples of AI-driven MBSE in practice, along with current limitations, integration challenges, and available tool support
- A live demonstration of AI supporting SysML v2 modeling, showcasing how AI-enhanced tools can streamline model creation and analysis

View the webinar here.
Learn more about Tom Sawyer Software's SysML v2 Viewer.

OMG® Europe Information Day 2025 Presentations

In May 2025, the Object Management Group (OMG) held its OMG® Europe Information Day 2025 event at the co-host's SLB R&D Center near Paris, France.

SYSTEMS ENGINEERING RESOURCES

This event covered how the modeling standards and ontologies developed by OMG enable the interoperability of industrial systems throughout the lifecycle of products. The participants covered new models, standards, and tools that support systems engineering, "digital thread" and digital twin initiatives, and the collaborative management of product artifacts across the supply chain.

Session presentations, downloadable in Zip file format, have been posted here, and include:

- OMG Standards Work relevant to Industrial Systems
- Digital Twins at SLB
- Ontology for airplane manufacturing
- OMG Standards for Systems Engineering
- Advancing Industrial Systems (of Systems) Engineering: leveraging MBSE with OMG UAF and SysML Standards
- W3C standards and related activities for digital twin
- Panel and open discussion: the future of model-based industrial systems

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NAFEMS Free Online Resources

The mission of NAFEMS includes being globally recognized as an "*independent authority and trusted source for communicating engineering simulation knowledge, and for sharing best engineering modeling, analysis, and overall simulation practices in developing reliable products and innovative solutions*." In support of this mission, NAFEMS publishes free online as well as members-only resources.

A recent search of the NAFEMS Resource Center filtering on "Free" items found 418 results, including four published in 2025:

- Engineering Simulation Maturity Assessment: An Introduction (12-page guide)
- NAFEMS ASSESS Initiative (Video recording from NAFEMS World Congress 2025)
- NAFEMS Technical Group Update (Summary of Technical Working Group progress)
- NAFEMS Dach Magazine Issue 073 (German language online magazine)

Register for a free NAFEMS account to access NAFEMS free online assets.

A very small sample of recent member-only titles includes:

- The State of AI in Engineering Simulation (article)
- Benchmark – Breathing Life into Simulation (journal)
- From Idea to Reality? Unlocking the Business Value of Digital Twins Throughout Product's Life Cycle (paper)
- Credibility of Simulation Models: A Brick-by-Brick Approach (presentation)

Join NAFEMS to access thousands of additional publications and videos.

NAFEMS also publishes a free online Glossary of valuable terms and definitions related to modeling and simulation, accessible without registration or membership.

SYSTEMS ENGINEERING RESOURCES

Waters Center Systems Thinking Resources

The Waters Center for Systems Thinking (WCST) continues to publish various systems thinking resources, including blog posts and how-to booklets.

Blog posts shared in 2025 include:

- How systems thinking can help you Thrive in 2025!
- Beyond the 'Any Questions?' Slide: How Systems Thinking Drives Real Change - Transform organizations by escaping the power of myths and rituals
- Developing the Capacity for Complexity - A Community of Practice Approach
- Leadership in Uncertain Times: Thinking Beyond Survival - How do leaders make decisions when the future is unknown?
- More Thinking - Benefits of Systems Thinking in Classrooms
- Navigating Change with Systems Thinking and Future Readiness - Preparing Education Systems for What's Next—Not Just What's Now
- Steady in the Storm - Leading with Mindfulness and Systems Thinking
- Systems Thinking in Action: How to Build Habits That Last - Using Science-Backed Strategies to Bring the Habits of a Systems Thinker into Your Daily Practice
- Telling a Systems Story - Why the Way We Tell Stories About Impact Matters. The Myth of Efficiency - Why Systems Thinking Is Worth the Time

The Waters Center Online Shop has a new resource that offers engaging strategies for building systems thinking capacity of any organization. The Systems Thinking Facilitator's Toolkit is a 40-page booklet that can introduce a group to systems thinking for the first time or take a team of seasoned practitioners to the next level. Also available is the 45-page guidebook, The Habit-Forming Guide to Becoming a Systems Thinker, Second Edition, which features a chapter for each of the 14 Habits and includes opportunities for practice and reflection.

Learn more about the Waters Center here.

IIBA Open-Access Resources

The International Institute of Business Analysis (IIBA) is a non-profit professional association that helps business analysts develop their skills and further their careers by providing access to relevant content. IIBA publishes a variety of open-access and members-only resources that are published in numerous media formats.

Analyst Catalyst Blog

This open-access blog features posts that address different aspects of the business analysis discipline. Recent topics include:

- Adapting Knowledge Areas to Elevate Your Business Analysis
- AI for Business Analysts: IIBA Ireland Event Recap
- Are You an AI-Ready Business Analyst?
- From Chaos to Control: How Business Analysis Transformed a GxP Process in Pharma

- Outputs vs. Outcomes: How Please Hold Rethinks Business Impact
- The Business Analyst's Challenge: Bridging the Gap Between Business Needs and Data Products
- What Business Analysts Should Know About Agile

Business Analysis Live! Podcasts
IIBA's podcast library is also open to non-members. Recent titles include:

- Business Analysis for Healthcare Projects
- Business Analysis in the Platform Era
- GenAI and Information Mapping
- Working with Project Managers

FINAL THOUGHTS FROM SYENNA

The case for better requirements, whether in galaxies far, far away—or in Hollywood boardrooms.

Systems engineers are supposed to know their stakeholders. Requirements elicitation, validation, context analysis—the bread and butter of our craft. Which is why it's hard not to wince when Disney, owner of some of the most powerful IP in the galaxy, seems to forget that basic principle.

Full disclosure: Like many engineers, I'm a geek at heart. I grew up on *Star Wars* and *Marvel*, and I still get goosebumps when a Star Destroyer looms into view or when the Avengers assemble. *Andor* was brilliant—dark, layered, respectful of its audience's intelligence. But much of the later output? More like a hastily drawn block diagram than a carefully engineered system: glossy outputs, fuzzy requirements.

Reports now suggest Disney is scrambling to win back Gen Z males—the very fans who once lined up in Stormtrooper armor and Iron Man suits. *Star Wars* audiences remain about 70% male, Marvel leans that way too, but both are showing fatigue. Younger fans are drifting to gaming, TikTok, and galaxies not run by corporate emperors.

From a systems perspective, the failure is textbook: stakeholder needs were assumed—and in some cases even forced on unwilling stakeholders. Instead of asking what long-time users wanted, Disney issued directives from the executive Death Star: *"You will consume this sequel… You will adore Phase Four (for the uninitiated, that's the much-hyped batch of Marvel movies and series after Avengers: Endgame, which left many fans unconvinced). Resistance is futile."* (Yes, Syenna is also a *Star Trek* fan.)

Which brings me to a favorite parallel: in engineering, we talk a lot about reuse. The Galactic Empire reused the Death Star design—twice—with the same catastrophic results. (Three times if you count Starkiller Base.) Starfleet, meanwhile, kept "refitting" the Enterprise with evolutionary tweaks—sometimes elegant, sometimes clumsy, but at least the ship usually came back. Both approaches say a lot about risk, reuse, and lessons learned—and about the perils of unimaginative recycling.

Of course, personal preference always plays a role. Many people genuinely enjoyed *Indiana Jones and the Dial of Destiny*, *The Little Mermaid*, or even *Willow's* brief revival—and that's fine. Entertainment doesn't live or die by box office alone. But when you set those newer efforts next to the cultural lightning strikes of *Raiders of the Lost Ark*, the original *Little Mermaid*, or the first *Pirates of the Caribbean*, the contrast in impact is hard to miss. One generation's "meh" is still another generation's favorite night out.

Now Disney wants new IP—splashy adventures and treasure hunts—to lure back fans. That's fine, but it feels a bit like trying to retrofit requirements on a Death Star that has already failed twice.

The lesson? Even with a treasure chest of legacy designs—or billion-dollar IPs—you can't dictate what your stakeholders *should* want. You have to listen. Otherwise you risk turning your biggest fans into skeptics with long memories and plenty of alternatives.

FINAL THOUGHTS

Because whether you're designing a spacecraft, a digital twin, or the next Marvel series, ignoring your stakeholders isn't just bad storytelling. It's bad systems engineering.

At least the Borg had configuration control… even if every drone looked like a different failed prototype.

So let me leave you with this: **Which is the better case study in systems failure—the two Death Stars (or three, if you count Starkiller Base) that kept blowing up, or the Enterprise that kept getting refitted and relaunched every few years? And maybe the bigger question: how many times can you recycle a franchise before it stops feeling like innovation and starts feeling like déjà vu?**

Regards,
Syenna

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