

Engineering for the Future: Integrated Solutions for Tackling Complexity

Systems Engineering and Artificial Intelligence: Evolution, Challenges & Application



PPI SyEN

EMAIL: PPISyEN@PPI-Int.com



EDITORIAL STAFF

Editor John Fitch

Editor-in-Chief Robert Halligan

Managing Editor René King

PRODUCTION STAFF

Marketing Manager Benjamin Bryant

Graphic Designer Matthew Wong

Marketing Coordinator Rebeca Carneiro

Publishing Assistants Trudy King Shalani De Silva

PUBLISHER



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

Tel UK: +44 20 3608 6754 Tel USA: +1 888 772 5174 Tel China: +86 188 5117 2867

www.ppi-int.com

© 2012-2024 Project Performance (Australia) Pty Ltd, trading as Project Performance International

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

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

WELCOME

Dear PPI SyEN Readers,

I am thrilled to present the 136th edition of PPI SyEN, themed "Engineering for the Future: Integrated Solutions for Tackling Complexity." This issue delves into the diverse ways our community is innovating to manage the intricate challenges of modern engineering.

We begin with significant SE news items, including the INCOSE Weber State University SEP Academic Equivalency Agreement and the unveiling of the Digital Twin Capabilities Periodic Table V1.1. The Systems Engineering Research Center (SERC) continues to provide valuable insights that propel our field forward, while the USA National Institute of Standards and Technology (NIST) is exploring opportunities in generative AI.

Our conferences, meetings and webinars section is loaded with opportunities for learning and engagement. From the MESCONF 2024 Modeling Conference to the IEEE Requirements Engineering 2024 Conference (RE'24) and beyond, each event offers an opportunity to enhance your capabilities in addressing complex systems challenges.

This edition also features a palatable article I wrote titled "Systems Engineering and Artificial Intelligence: Evolution, Challenges, and Applications." The article explores the evolving interface between systems engineering and AI, aiming to deepen my own understanding of the evolution and intersection between these domains.

Supporting your journey in tackling complexity, we've included resources such as the INCOSE INSIGHT Practitioners Magazine and featured content from the Multisolving Institute's YouTube Channel. These resources provide opportunity to broaden your perspectives in problem solving within engineering.

We conclude with Syenna's witty reflections on "The Art of Systems Engineering Under Various Guises." Please share your thoughts on this edition at ppisyen@ppi-int.com. We are committed to continually enhancing the value we deliver to our community.

Warm regards,

René

Managing Editor (on behalf of the PPI SyEN team)

	PPI Sv	EN EDI	TION 136	MAY	2024
--	---------------	--------	-----------------	-----	------

SYSTEMS ENGINEERING NEWS Recent events and updates in the field of systems enginneering	4
CONFERENCES, MEETINGS & WEBINARS Upcoming events of relevance to systems engineering	11
FEATURE ARTICLE	25
By Rene King (Project Performance International)	oplication.25
Systems Engineering and Artificial Intelligence: Evolution, Challenges & Ap By Rene King (Project Performance International) SYSTEMS ENGINEERING RESOURCES	oplication.25

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

START A NEW CHAPTER IN YOUR CAREER?

Already an outstanding SE professional? Ready for a career and lifestyle change?

Project Performance International (PPI) seeks top-notch SE Professionals worldwide to meet the skyrocketing demand for our training and consulting. Opportunities exist for online and in-person delivery in most regions. A rigorous qualification process applies; this itself is career-boosting.

There are opportunities to join our team through one of three engagement models:

- o *full-time employment*
- o part-time employment
- independent contractor, perhaps with your own trading entity, with exclusivity to PPI for SE-related training, otherwise free to consult independently.

Interested? managingdirector@ppi-int.com

PPI Systems Engineering Newsjournal (PPI SyEN) seeks:

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

PPI defines systems engineering as:

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

Recent events and updates in the field of systems engineering

INCOSE: Weber State University SEP Academic Equivalency Agreement



INCOSE has announced that an Academic Equivalency Agreeement has been approved for courses at Weber State University (WSU). Students who do well in university courses which have been assessed to have Academic Equivalence (AcEq) are allowed to bypass the certification knowledge exam when applying for ASEP and CSEP Certification. The assessments they complete through their coursework have

been recognized by the INCOSE Certification Program's volunteer reviewers as an equivalent alternative to the standardized test developed by INCOSE.

Learn more about the Academic Equivalency process <u>here</u> and in the <u>Certification Blog</u>.

Weber State offers a 100% online Master of Science in Systems Engineering (MSSE) program with flexible learning options. Learn more <u>here</u>.

Digital Twin Capabilities Periodic Table V1.1 Released



The Digital Twin Consortium (DTC) has announced the release of Version 1.1 of the <u>Digital Twin Capabilities Periodic Table (CPT)</u>. CPT is an innovative architecture and requirements definition framework for organizations across industry who want to design, develop, deploy, and

operate digital twins based on use case capability requirements rather than technology-specific features.

DS.AI Data Acquisition & Ingestion	DS.SG Synthetic Data Generation	IR.ET Enterprise System Integration	IC.SR Search	IC.PR Prediction		UX.BV Basic Visualization	UX.DB Dashboards
DS.ST Data Streaming	DS.ON Ontology Management	IR EG Eng. System Integration	IC.CC Command & Control	ICAI Artificial Intelligence		UX.AV Advanced Visualization	UX.CI Continuous Intelligence
DS.TR Data Transformation	DS.RP Digital Twin (DT) Model Repository	IR10 OT/IoT System Integration	IC.OS Orchestration	IC.PS Prescriptive Recommendations		UX.RM Real-time Monitoring	UX.BI Business Intelligenc e
DS.CX Data Contextualization	DS.IR DT Instance Repository	IRDT Digital Twin Integration	IC.AL Alerts & Notifications	IC.FL Federated Learning	IC BR Business Rules	UX.ER Entity Relationship Visualization	UX.BP BPM & Workflow
DS.BP Batch Processing	DS DS Domain Specific Data Management	IR.CL Collisb Pistform Integration	IC.RP Reporting	IC.SM Simulation	IC.DL Distributed Ledger & Smart Contracts	UX.XR Extended Reality (AV/VR/MR)	UX.GE Gaming Engine Visualization
DS.RT Real-time Processing	DS.SA Data Storage & Archive Services	IR.AS API Services	IC.AA Data Analysis & Analytics	IC MA Mathematical Analytics	IC.CS Composition	UX.GM Gamification	UX.3R 3D Rendering
DS.AS Asynchronous Integration	DS.SR Simulation Model Repository	MG-DM Device Management	MGEL Event Logging	TWEC Data Encryption	TW.SC Security	TW:SF Safety	TW.RP Responsibility
DS.AG Data Aggregation	DS.AR AI Model Repository	MG.SM System Monitoring	MG.DG Data Governance	TWDS Device Security	TW.PR Privacy	TWRL Reliability	TW.RS Resilience
Data Services		Intelligence) UX 🔿 Manaser	nent 🦱 Trustworthi	ness		

CPT Version 1.1 improvements include:

• Responsibility as a Core Capability

- Search Capability
- Consolidated and Refined Capabilities
- Domain Specific Data Management
- Structured Abbreviations
- Capability Mapping

Download CPT V1.1.

Work on V2 of the CPT is underway by the DTC's Composability Framework Subgroup to:

- increase interoperability with AI
- better incorporate geospatial and related spatial computing topics
- provide more guidance on aligning use cases.

View the Composability Framework 1.1 press release.

Learn more about the <u>Digital Twin Consortium</u>.

Intercax Syndeia 3.6 Released



Intercax has announced the release of version 3.6 of <u>Syndeia[™]</u>, a software platform for integrated model-based engineering that federates models and data from diverse ecosystems of modeling and simulation tools, enterprise applications, and data repositories.

Syndeia 3.6 includes features that support accelerated concurrent digital engineering for missioncritical products and systems. New and enhanced features include:

- Enterprise-scale digital threads, visualized in a dashboard that provides a "single pane of glass" for integrated digital engineering
- Query Library that supports collections of digital thread graph queries
- Live navigation of digital threads spanning integrated data sources and repositories
- Digital thread analytics and reports that provide live metrics
- Baselining and baseline comparisons of digital thread projects

New integrations have been added with:

- GENESYS (Vitech/Zuken)
- DS-E3 (Zuken)
- DS-CR (Zuken)

The Teamcenter integration is now live on the Syndeia Web Dashboard and API.

See more details on Syndeia 3.6 <u>here</u>. View a "<u>What's New" video</u>.

Learn more about Intercax products and services.

Systems Engineering Research Center (SERC) Updates

SYSTEMS ENGINEERING RESEARCH CENTER

An <u>April update</u> from the Systems Engineering Research Center (SERC) includes reports and articles that explore important topics at the leading edge of systems engineering practices.

Test and Evaluation Methods for Middle-Tier Acquisition

A summary report has been published for a multi-year Department of Defense (DoD) project to advance Test and Evaluation (T&E) methods. The research team focused on three aspects of this challenge:

- Test the Way We Fight
- Accelerate the Delivery of Weapons that Work
- Pioneer T&E of Weapon Systems Built to Change Over Time

Download the Executive Summary and Full Report.

Digital Transformation in Test and Evaluation for AI/ML, Autonomous, and Continuously Evolving Systems

A second report has been published that dives into more detail on the project described above. This report summarizes research on the topic, *Pioneer T&E of Weapon Systems Built to Change Over Time*. The research objective was to explore current industry practice in applying digital engineering methods to test and evaluation of DoD acquired systems and provide recommendations on how to promote further adoption in the T&E community.

Download the Executive Summary and Full Report.

Toward Collective Impact in DoD's STEM Activities and Outreach

This final report details the work of a team that examined the DoD's challenges and opportunities for developing a workforce with advanced STEM skills.

Interview with Dr. Paul Wach, Virginia Tech

This April 2024 article summarizes an interview with Dr. Paul Wach concerning his research on developing a practical theory that provides a scientific foundation for engineering systems within the evolving digital paradigm.

Good Reads About Systems

The SERC community periodically publishes its recommendations for "Good Reads About Systems". Recent candidates to consider include:

- Carlo Lipizzi, Societal Impacts of Artificial Intelligence and Machine Learning
- David Marquet, Turn the Ship Around: How to Create Leadership at Every Level
- Michael Pierce and Bruce G. Cameron, <u>A Sheep in Wolf's Clothing: SysML is not living up to</u> the hype of revolutionizing product development
- <u>The Proceedings of the 2023 Conference on Systems Engineering Research: Systems</u> <u>Engineering Towards a Smart and Sustainable World</u>
- Leadership and Self-Deception: Getting Out of the Box

Access the latest SERC news here.

Follow SERC on LinkedIn.

Congratulations to Dr. Ronald Carson: Industry Engineer of the Year 2024



Project Performance International's subsidiary, Certification Training International (CTI), is delighted to extend our heartfelt congratulations to our very own Dr. Ronald Carson (ESEP) for being named the 2024 Industry Engineer of the Year by the Puget Sound Engineering Council. This prestigious award is a testament to Ron's exceptional contributions to systems engineering and his technical leadership within the aerospace industry.

Ron's career is a remarkable journey marked by innovation, dedication, and a profound impact on the field of systems engineering. At Boeing, he authored numerous engineering design standards that have become essential to the company's operations. As a Boeing Technical Fellow, Ron was instrumental in the development and deployment of model-based systems engineering processes. Following his retirement from Boeing in 2015, Ron continued to share his knowledge as an Affiliate Assistant Professor at the University of Washington and an Adjunct Professor at Seattle Pacific University. His passion for education has influenced countless students and professionals, ensuring the next generation of systems engineering practitioners are well-equipped for the future. In 2022, we were fortunate to have Ron join CTI as a course facilitator. His expertise and dedication have been invaluable in preparing individuals worldwide to pass the INCOSE Knowledge Examination and achieve SEP certification.

Ron, your achievements and this well-deserved honor inspire all of us to strive for excellence in everything we do. Congratulations!

NIST Generative AI Opportunities



The U.S. National Institutute for Standards and Technology (NIST) is offering two opportunities to influence the future of Generative Al.

Public comments are sought by no later than 2 June 2024 on four draft technical and policy documents that address the risks associated with Generative AI:

- NIST AI 600-1: AI RMF Generative AI Profile
- NIST AI 100-5: A Plan for Global Engagement on AI Standards
- NIST AI 100-4: Reducing Risks Posed by Synthetic Content
- <u>NIST SP 800-218A</u>: Secure Software Development Practices for Generative AI and Dual-Use Foundation Models

NIST is also launching a GenAl Challenge, a new program to evaluate and measure generative Al technologies.

Learn more and register to participate in the GenAI Challenge.

PDMA Carolina's Student Innovation Competition



The Carolinas chapter of the Product Development Management Association (PDMA) hosted their 15th annual local conference, Innovate Carolina, on 18 April 2024. A highlight of this conference was the PDMA <u>Carolina's Student Innovation</u> <u>Competition</u> which showcased the innovation skills of 25 students and 7 faculty advisors on teams from Clemson University, University of North Carolina Charlotte and Rice University.

Awards were given as follows:

- First Place Undergraduate Level: Bloom from Clemson University.
- First Place Graduate Level: IVN from Rice University
- Second Place Undergraduate Level: eWalk from Clemson University
- Third Place Undergraduate Level: NephroGuard from Clemson University
- Third Place Graduate Level: StepSync from Clemson University

In the keynote talk for this event, *Foundations of Human Connections in Product Development*, Dr. John Tudor identified keys to project success as being Purpose, Confidence and Resilience.

View the keynote and team presentations here.

Learn more about the <u>PDMA Carolinas chapter</u>.

SE 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: Altair Engineering Inc.

- <u>SimSolid</u>: Game-changing simulation technology for designers, engineers, and analysts. It eliminates geometry preparation and meshing: the two most time-consuming, expertise-extensive, and error-prone tasks performed in a conventional structural simulation.
- <u>Altair® Twin Activate</u>[™]: An open and flexible integration solution that enables whole system simulation with real-time digital twin deployment through any stage of the product lifecycle.
- <u>Altair® PollEx™</u>: Accelerates the development of today's smart, connected, and tightly packaged electronic products. PollEx enables teams to review and improve board layouts, and drive designs with simulation tools for signal integrity, power integrity, EMI vulnerability, and ESD protection.

Vendor: <u>Ansys Inc.</u>

• <u>Ansys Twin Builder</u>: A multi-technology platform that allows engineers to create simulationbased digital twins-digital representations of assets with real-world or virtual sensor inputs. • <u>Ansys medini Enterprise</u>: Dramatically decrease safety and security analysis efforts, while accelerating time to market with state-of-the-art methods in the model-based environment of Ansys medini analyze.

Vendor: Change Vision, Inc.

- <u>Astah System Safety</u>: A modeling tool for safety-critical systems to support system architecture modeling, system safety assessment and analysis.
- <u>Astah Professional</u>: Helps you create UML diagrams, ER Diagram, Flowchart, and DFD and more to create a clear understanding of your software design among teams.
- <u>Astah SysML</u>: A lightweight SysML diagramming tool which is perfect for systems engineering.
- <u>Astah UML</u>: Will allow you to create a set of UML 2.x diagrams for your project.

Vendor: Cinergix Pty Ltd

- <u>creately</u>: A visual collaboration platform that makes it easier for your team to collaborate and work more efficiently together. Features include brainstorming and ideation, diagramming, whiteboarding, planning, running workshops and meetings, managing projects, research and analysis and more.
- <u>creately viz</u>: Al powered visual intelligence. Generate visuals in a snap, uncover new perspectives, automate tasks all with Al wizardry.

Vendor: <u>CodeKick AB</u>

• KanBanFlow: A lean project management tool intended for use by teams for implementing Kanban boards. It can be used free or by monthly subscription. Features include importing and exporting in several formats, add tasks by email and features a REST based API.

Vendor: Eclipse Foundation AISBL

• Capella: A comprehensive, extensible, and field-proven open source MBSE tool and method to successfully design systems architecture. Capella relies on Arcadia a field-proven model-based methodology that covers each engineering phase.

Vendor: <u>Lumina Decision Systems</u>

• <u>Analytica</u>: A visual software environment for building, exploring, and sharing quantitative models to help people make effective decisions. The experience of using it is very different from its usual alternatives: spreadsheets and scripting languages like Python and R.

Vendor: Obeo

• <u>Eclipse SysON</u>: Provides an open-source web-based tooling to edit SysML v2 models. It includes a set of editors (graphical, textual, form-based, etc.) enabling users to build the various parts of system models.

Vendor: <u>SENSmetry</u>

• SysIDE: Open-source SysML v2 textual editing and analysis system. SysIDE (pronounced "seaside") provides SysML v2 language support in VS Code and can be used an Integrated Development Environment. SysIDE was developed and currently maintained by Sensmetry.

Vendor: Siemens Polarion

- <u>Polarion</u>: The Polarion Unified Platform enables development organizations to streamline, automate, and optimize development processes across multiple projects and lifecycles.
- <u>Polarion ALM</u>: Everything you need to accelerate innovation in one Unified Solution. Connect your teams and projects, and improve application development processes with a single, unified solution for requirements, coding, testing, and release management.
- <u>Polarion QA</u>: Complete Quality Assurance and Testing Solution Design, coordinate, and track all your test management activities in a single, collaborative QA environment.
- Polarion PRO: Unify change management, task & issue tracking and work reporting across all project contributors across the enterprise. Leverage native ReqIF and MATLAB Simulink integration for information exchange, and comprehensive traceability.
- <u>Polarion Reviewer</u>: Enable internal and external stakeholders to review and comment on work items, and provide industry-compliant electronic signatures and approvals.
- <u>Polarion Variants (Add-On</u>): Evolve capabilities in development lifecycles to effectively manage variation, mass customization, and 'configured-to-order' deliverables. Polarion is the only ALM solution with variant management capability.
- <u>Polarion for Automative</u>: Collaborate across complex internal and supplier ecosystems. Accelerate Functional Safety compliance for ISO 26262, Automotive SPICE and CMMI standards. Model Driven development with Polarion's Diagram Editor, plus integration with Sparx Systems Enterprise Architect[™] and with MATLAB® Simulink[™].

Vendor: <u>SpicySE</u>

• Spicy SE: Enables your team by providing unmatched accessibility to the world of SE. Define system boundaries and interfaces to aid collaboration easily, develop requirements, architectures, tests etc. like never before. Everyone can participate right from the start. Never lose any great ideas again!

Vendor: Statgraphics Technologies, Inc.

• <u>Centurion:</u> A comprehensive Windows desktop product for statistical analysis, data visualization and predictive analytics and includes over 290 statistical procedures and special features, with many recent additions in the areas of data visualization, predictive analytics, data mining and machine learning.

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

Access the <u>SETDB website</u>.



M2Doc for Capella Online Training



<u>Capella</u> is an open-source solution for model-based systems engineering. <u>M2Doc</u> supports template-driven document generation from Capella system models.

<u>OBEO</u> is offering online "<u>M2Doc for Capella Training</u>" on 3-7 June, taught by a member of the M2Doc development team. Delivered as five sessions of 3.5 hours each, this course will enable participants to:

- Understand the principles of document generation from Capella models.
- Query a Capella model to automatically retrieve structured data.
- Implement M2Doc templates to generate MS Word documents.

Please contact <u>sales@obeosoft.ca</u> for more details on this course.

MESCONF 2024 Modeling Conference



MESCONF 2024, a modeling conference conducted in German, will take place on 6-7 June in Munich. This 11th edition of the MESCONF is <u>organized by</u> Andreas Willert (<u>Willert Software Tools</u>), Alexander

Huwaldt (<u>SiSy Solutions</u>), Alexander Schneider and Tim Weilkiens (oose). MESCONF focuses on the practical applications and experiences that users have had when using modeling for architectural design and software development, particularly in the development of embedded systems. Model-based systems engineering (MBSE) is another theme of MESCONF.

The keynote address for MESCONF 2024, *Railway Mining – Punctuality is an adornment*, will be delivered by David Kriesel.

A sample of technical presentations includes:

- AUTOSAR software architecture, application development, debugging, and testing
- Function-oriented development with MBSE and potential for the use of AI
- Getting started with model-based development What influence does the new SysML v2 have on established MBSE methods?
- Guided System Modeling with Rhapsody and the transition to the software and E/E domain
- Model Governance for the Digital Engineering of the Future: IncQuery Validator Product Launch
- System Architecture Modeling of an Electric Vehicle with MathWorks Toolchain

Download a 2-page conference overview.

Webinar: The Future of Digitalizing your Innovation Portfolio



The Product Development Management Association (PDMA) will host a free webinar on 6 June 2024 titled *"The Future of Digitalizing your Innovation Portfolio"*. Paul Heller of Sopheon will share his insights on innovation portfolio best practices.

Learning objectives for this event include:

- Understand the main elements of an innovation portfolio
- Learn how to analyze and identify a good innovation portfolio
- Summarize what tools are necessary to improve portfolio management
- Discuss how AI can improve portfolio management

Learn more and register here.

Kongsberg Systems Engineering Event (KSEE 2024)

University of South-Eastern Norway is Revisiting what does the progress in AI mean for Systems Engineering?

The progress in generative AI, e.g. ChatGPT, has once more increased the buzz level of AI. We like to explore how AI is actually being used today (for example to populate concept space, or as pattern recognition in systems) and what the consequences are for systems engineering (for the previous examples respectively speeding up and broadening in the early phase, challenges in qualification and certification).

The keynote speaker for KSEE 2024 will be Dr. Remco Schoenmakers, Director Data & Artificial Intelligence, Thermo Fisher Scientific. Dr. Schoenmakers will speak on *Learning the language of nature: Generative AI for electron microscopy applications*.

Planned presentations on this challenging topic include:

• Keynote: *Better together: how system- and software engineers can cooperate to innovate faster.* (Dirk-Jan Swagerman, Chief on demand Innovation & Systems at Buffadoo)

Learn more about KSEE 2024 here.

<u>Register</u> for KSEE 2024 no later than 5 June. There is no admission fee, but the conference has a maximum capacity of 150 seats.

34th European Safety and Reliability Conference (ESREL 2024)



The European Safety and Reliability Association (ESRA) is hosting the 34th European Safety and Reliability Conference (ESREL 2024) on 23-27 June in Cracow, Poland. ESREL is the annual event for reliability analysis, risk assessment, risk management and optimization of the safety performance of socio-technological systems. A Post ESREL 2024 Workshop will follow on 28-30 June, dedicated to training courses and research projects in reliability, safety and security.

Keynotes for ESREL 2024 include:

- Health Aware Control and RUL Control of Degrading Systems (Christoper Berenguer, Université Grenoble Alpes, France)
- Reliability of conventional electric power supply versus self-sufficient supply (Marko Čepin, University of Ljubljana, Slovenia)
- Survival Signature for System Reliability: Inference and Decision Support (Frank Coolen, Durham University, UK)
- Digital Twins for Trustworthy Autonomous Systems (Francesco Flammini, University of Applied Sciences and Arts, Switzerland)
- Sustainability, safety, and security related research challenges in times of dynamic global and regional changes (Kazimierz Kosmowski, Polish Safety and Reliability Association, Poland)
- Bayesian Belief Nets Models in Safety and Reliability (Dorota Kurowicka, Technical University Delft, Netherlands)
- Recent Research Progresses in Reliability of Autonomous Systems (Yan Fu Li, Tsinghua University, China)
- Asymptotic Approximation Techniques for Reliability of Complex Systems (Nikolaos Limnios, Université de Technologie de Compiègne, France)
- Resilient Water Infrastructure at Climate Change Conditions (Dieter Lompe, University of Applied Sciences Bremerhaven, Germany)
- Multi-State Systems and their Applications in Reliability Analysis (Elena Zaitseva, University of Žilina, Slovakia)

A broad set of <u>application domains</u> will be addressed with a range of methodologies presented:

- Accident and incident modelling
- Complex systems and critical infrastructure reliability, safety and security modelling and optimization
- Complex systems and critical infrastructures maintenance strategies
- Complex systems and critical infrastructure business continuity modelling and optimization
- Crisis management support systems
- Cybersecurity and functional safety in hazardous systems
- Disaster preparedness, mitigation and response
- Human factors in system reliability, safety and security
- Mathematical methods in reliability, safety and security
- Monitoring and early warning systems
- Occupational safety
- Prognostics and system health management
- Reliability, safety and security of components and systems

- Reliability, safety and security related management systems
- Research challenges concerning sustainability, safety and security
- Risk and reliability assessment and management
- Security, vulnerability and resilience of systems
- Simulation based methods for reliability, safety and security
- Statistical methods in reliability, safety and security
- Uncertainty analysis

View the ESREL 2024 conference program. Register here.

View the Post ESREL 2024 Workshop program. Register here.

IEEE Requirements Engineering Conference (RE'24)



Registration is open for the <u>32nd IEEE International Requirements Engineering 2024</u> <u>Conference (RE'24)</u> to be held in Reykjavik, Iceland from 24-28 June. The conference enables researchers, practitioners, students, and educators to meet, present and discuss the most recent innovations, trends, experiences, and issues in the field of requirements engineering.

The theme of RE'24 is Exploring New Horizons: Expanding the Frontiers of Requirements Engineering.

Keynote talks for RE'23 include:

<u>Automation for Requirements Engineering: Opportunities and Pitfalls (Jan Mendling, Humboldt-Universität</u> <u>zu Berlin, Germany)</u>

Recent technologies like ChatGPT inspire ideas of increasing automation for professional tasks in various domains. This includes among others, requirements engineering. So far, however, the divide between useful and harmful automation has been blurry and in flux. In this keynote, I will discuss foundational concepts with which automation has been analyzed. Using these concepts, I will discuss the opportunities arising for requirements engineering from the advent of natural language processing, image processing, and event sequence analysis techniques. Furthermore, I will discuss important pitfalls that have been well documented for other automation technologies in the past.

Paradigm Shift with GenAl (Marija Mikic, Google Labs)

GenAl is bringing a profound shift in just about every area of our lives - how we interact, work, and as engineers, how we build products and systems. Some changes are already here while others will take time to play out. In this talk I will focus on what this generational technology shift means for the current web and highlight some of the areas we should be focused on to successfully apply this technology to many domains.

<u>Requirements Engineering for Trustworthy Human-AI Synergy in Software Engineering 2.0 (David Lo,</u> <u>Singapore Management University, Singapore)</u>

Software Engineering 2.0 envisions synergistic collaborations between humans and AI agents that are diverse, responsible, and autonomous, aiming to build the software of tomorrow - a vision that has garnered significant attention recently. Despite this growing interest, we are only beginning to unravel the complexities of fostering this synergy to develop trusted software that benefits society. This keynote will (i) highlight existing efforts to engineer the requirements for this new paradigm of

software development, and (ii) chart the road ahead where Requirements Engineering can play a crucial role in defining the sine qua nons - the indispensable elements that ensure Software Engineering 2.0 can meet the diverse needs of various stakeholders.

Presentation content for RE'24 is organized into the following tracks:

- <u>Research Papers</u>: Original research papers focusing on traditional areas of requirements engineering, as well as new ideas which challenge the boundaries of the area.
- <u>RE@Next! Papers</u>: Venue to present ongoing work that has generated early or preliminary results.
- <u>Industrial Innovation Papers</u>: Full industry papers, presentation-only contributions, invited presentations, and interactive formats for discussing the most recent innovations, experiences, and concerns in the discipline of Requirements Engineering.
- <u>Posters and Tool Demos</u>: Opportunity for researchers and practitioners to demonstrate and try out their methods and tools as well as gather feedback about them from the conference attendees.
- <u>Artifacts</u>: To foster reusability of a dataset, tool, script, experimental protocol, codebook, or other executable or non-executable object in the requirements engineering field.
- <u>Doctoral Symposium</u>: Opportunity for Ph.D. students and doctoral candidates to present their research work in progress to the panel of internationally renowned RE experts and receive constructive feedback.
- <u>Journal-First</u>: Authors of selected journal-first papers to present and discuss their research with the RE community.
- T<u>utorials</u>: To deliver requirements-related concepts and skills.

Register for RE'24.

RE'24 also provides the venue for numerous recurring <u>workshops</u>, relevant to the RE community, that will take place on 24-25 June:

- <u>RE4Web3</u>: Requirements Engineering for Web3 systems
- CrowdRE: The 8th International Workshop on Crowd-Based Requirements Engineering
- ModRE: 14th International Model-Driven Requirements Engineering Workshop
- <u>REWBAH</u>: 5th International Workshop on Requirements Engineering for Well-Being, Aging, and Health
- <u>ESPRE</u>: 11th International Workshop on Evolving Security and Privacy Requirements Engineering
- EnviRE: The 4th International Workshop on Environment-Driven Requirements Engineering
- <u>AIRE</u>: 11th International Workshop on Artificial Intelligence and Requirements Engineering
- <u>EmpiRE:</u> 9th Workshop on Empirical Requirements Engineering

PPI SyEN readers are encouraged to investigate the scope and objectives of these companion events.

IIBA Webinar: Futureproof - Delivering Value with Business Analysis and AI



The International Institute of Business Analysis (IIBA) is hosting a free openaccess business analysis webinar on 24 June titled *Futureproof - Delivering Value with Business Analysis and AI*. Angela Wick (BA-Cube.com) and Tim Coventry (BAPL) will lead the exploration of this topic, based on their book,

Futureproof: Amplifying Agility with AI and Insightful Business Analysis. Themes to be addressed include:

- Elevating business analysis practices
- Achieving strategic alignment with AI initiatives
- Driving value through analysis
- Fostering continuous improvement

Learn more and register <u>here</u>. Non-members of IIBA can create a free account on the IIBA site in order to register.

Learn more about the <u>Futureproof book</u>. Purchase the book <u>here</u>.

View prior IIBA public webinars <u>here</u>. Learn more about the <u>IIBA</u>.

OMG 35th Anniversary Webinar Series



The <u>Object Management Group (OMG</u>) is celebrating its 35th anniversary with a webinar series that highlights how OMG has shaped the landscape of technology standards and laid a foundation for the future of digital

transformation. Upcoming webinars include:

Domain Taxonomies for Data Governance (27 June)

In this webinar, you will learn how to use the Cloud Working Group discussion paper on "Domain Taxonomies for Data Governance," issued by OMG in December 2023, to identify, inventory, tag and manage sensitive information stored in the cloud. The "domains" of the title refer to personal data protection, export controls, classified or defense information, and intellectual property. The paper also presents some of the mechanisms and tools that can be used to secure such information, and a scheme to attach classification labels to each dataset.

The Past, Present and Future of the DDS Standard (1 August)

From its first use case with the US Navy to today's breadth of applications, the Data Distribution Service (DDS) standard has stood the test of time in enabling real-time communications across distributed systems. Please join this panel in a lively discussion that includes:

- Why DDS has stood the test of time
- Unexpected use cases and applications running DDS
- The process to expand the DDS standard
- What's next in DDS

OMG hosted the first webinar in the series, <u>Essence – The Standard Bearer for High-Performing</u> <u>Teams</u>, on 16 May. This talk explored some of the use cases of Essence and the value it can provide to

various stakeholders, including the methodologist, the team, and the organization. Success stories were shared, along with descriptions of some of the changes proposed for Essence 2.0 and the drivers behind them. The role of Essence in AI was also discussed.

OMG's <u>BrightTALK channel</u> is the source for a numerous additional on-demand talks of standards topics such as DDS, Essence, AI, SysML V2, and Critical Infrastructure.

INCOSE International Symposium (IS2024) - Program Details



<u>Program details</u> for the INCOSE International Symposium (IS2024) have been released. IS2024 is being offered as a hybrid conference to be held from 2-6 July 2024. The inperson venue is the Dublin, Ireland <u>Convention Centre</u>.

IS2024 will offer two different experience levels, in-person and virtual participation. Common elements of both experiences include:

- 4 days
- Keynotes
- Invited content
- Best papers presentations
- Broadcast sessions available for replay on the IS2024 app
- Recordings of all sessions available from the INCOSE website 60 days post IS

The <u>in-person experience</u> will provide a range of unique opportunities to learn and network, including:

- On-site Program, consisting of 6 parallel tracks with over 200 presentations, round tables and panels.
- SE Fundamentals
- Saturday SE Tutorials (1 day)
- Networking gatherings

The <u>virtual experience</u> will provide a subset of the technical program, with approximately 40 sessions included. Virtual participants will have access to online chat capabilities to support remote networking.

See more details at the IS2024 event web site.

See registration details <u>here</u>.

Keynotes and Agenda: 2024 NAFEMS Americas Conference



The 2024 NAFEMS Americas Conference will take place in Louisville, Kentucky, USA on 9-11 July. This event will bring together the leading visionaries, developers, and practitioners of CAE-related technologies in an open forum, to share experiences, discuss relevant trends, discover common themes, and explore future issues. The

theme of the conference is Innovate - Integrate - Inspire: Creating a New Simulation Journey.

The key topics this conference will address are:

- Simulation-Driven Design (...of Physical Systems, Components & Products)
- Implementing a Simulation Governance Ecosystem with an Engineering Simulation Maturity Framework, Including Verification, Validation & Uncertainty Quantification
- Exploiting Engineering Simulation and Optimization for Competitive Manufacturing Processes & Additive Manufacturing
- Addressing Business Strategies, Challenges & Advanced Technologies (e.g., Integrating Engineering Simulation Digitalization within a Digitally Transformed Core Business Ecosystem)
- Frontiers of Data-Science Based Engineering Simulations Founded on Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL) & AI Physics Models

Keynotes include:

- The Role of Higher Ed in the Pursuit of Business Value, Innovation, and Governance in Engineering Analysis & Simulation (Anthony Petrella, Colorado School of Mines)
- Simulation Data Driven Product Development (Alice Popescu-Gatlan, John Deere)
- Application of Digital Engineering Methods and Virtual Environments in the Development and Certification of Small Unmanned Air Systems (Gerardo Olivares, National Institute for Aviation Research)

Technical presentations will be organized into the following tracks:

- Advanced Methods
- Al/ Machine Learning & Data
- Bio-Medical Physics
- CAE for Product Design
- Certification by Analysis
- CFD
- Consumer Products, Food and Drink
- Electromagnetics
- Material Modeling & Additive Manufacturing
- Modeling and Collaboration
- Multiphysics and Multiscale
- Simulation Engineering Support
- Simulation Process and Data Management
- Structural Dynamics and Durability
- Systems Modeling and Simulation

During the conference, opportunities exist to influence the direction of the simulation community by participating in NAFEMS Americas working groups, including:

- Engineering Data Science
- Simulation Governance Management
- Stochastics

Download the conference agenda.

Register <u>here</u>.

Applied Human Factors and Ergonomics Conference (AHFE 2024)



The 15th International Conference on Applied Human Factors and Ergonomics (AHFE 2024) will take place on 22-27 July at Université Côte d'Azur in Nice, France. A virtual participation option is also provided. The conference provides an international forum for the dissemination and exchange of up-to-date scientific information on theoretical, generic and applied areas of Applied Human Factors and ergonomics (HFE), Human Computer Interaction (HCI), Neuroergonomics and Human Systems Integration (HSI), and Human Autonomy Teaming and Simulation. AHFE 2024 content will span a diverse range

of affiliated conferences and tracks.

The main conference offerings will be preceded by 14 half-day tutorials offered on 22-23 July. A sample of the tutorial topics includes:

- Next Generation Simulation and Training using Virtual Reality and Augmented Reality
- Fundamentals in Data Visualization and Dashboard Design
- Great UX Design: Twelve steps to a great user experience
- Human Factors and Cybersecurity
- Modern Heuristic Design Evaluation

The keynote address for AHFE 2024 will be delivered by Dr. Roger Daglius Dias, Harvard Medical School, USA on the topic, *Innovations in Healthcare Technology: Digital Biomarkers of Teamwork in the Operating Room*.

The 22 technical sessions planned for Day 1 (24 July), each with multiple presentations, provide a flavor for the breadth of topics to be addressed:

- 3D Prototyping and Additive Manufacturing
- Approaches to Aging Workforce and Special Needs
- Autonomous and Automated Driving
- Current Investigative Processes and Future Visions with Artificial Intelligence
- Design and Evaluation for Safety
- Design for All and Cultural Heritage
- Design Strategy and User Experience
- Ecosystem-Based Data Economy
- Explorations in Design Education
- Human-Centered Metaverse and Digital Environments
- Human Digital Twins Across Domains and Perspectives
- Human Factors for Apparel and Textile Engineering: Wearability and Function Human Factors in Naval Aviation Training: The Intersection of Automation and Simulation
- Human Factors in Robotics Research: Convergent Approaches
- Human Performance and Reliability Analysis
- Industry 4.0 and Intelligent Manufacturing Technologies
- Innovations in Digital Technology for Cultural Heritage in Communication

- Playing with Cyber Security: Using Games to Understand the Issues
- Sensory Engineering and Emotion
- Sounding Better: Alarms and Soundscapes in Healthcare
- Systems Engineering Applications
- Workspace Design and Safety

View the <u>full conference program</u>. Register <u>here</u>.

Investigate prior AHFE conferences here.

2024 International System Dynamics Conference (ISDC 2024)



The <u>System Dynamics Society (SDS)</u> is hosting the 2024 International System Dynamics Conference (ISDC 2024) on 4-8 August 2024 in Bergen, Norway (and also online). The theme of ISDC 2024 is "*Bridging Perspectives for New Insights*".

<u>Conference speakers</u> include:

- <u>Cleotilde Gonzalez</u>, Carnegie Mellon University: *Cognitive Artificial Intelligence -Building Human-Like Artificial Agents*
- <u>Etiënne Rouwette</u>, Radboud University
- <u>Margaret Brandeau</u>, Stanford University
- <u>Scott E. Page</u>, University of Michigan: *Cultural Alignment in Organizations A Systems Perspective*

Technical presentations will be organized into the following topical threads:

- Business and Strategy (Competitive Dynamics, Marketing, New Business Models, Project Management, Strategy Development)
- Diversity (Age and Ability, Equity and Inclusion, Gender and Sexuality, Racial Justice)
- Economics (Business and Financial Organization, Economic Growth and Development, Equity and Income Distribution, Macroeconomics, Microeconomics)
- Environment and Resources (Agriculture and Food, Air, Water, and Land Use, Climate Change, Ecology and Biodiversity, Energy and Fuels, Environmental Regulation, Pollution and Waste Management)
- Health (COVID-19, Epidemiology, Health Disparities, Physiology, Population Health, Treatment and Disease Management)
- Learning and Teaching (Community Dissemination, Interactive Activities, Learning Experiments, Pedagogy and Curriculum)
- Operations (Capacity Management, Project Management, Service Operations, Supply Chains, Workflow, Workforce Planning)
- Methodology (Artificial Intelligence, Graphical Presentation Formats, Hybrid Modeling Approaches, Model Analysis, Model Development, Qualitative Methods, Model Validation)
- Psychology and Human Behavior (Cognitive Science, Community Development, Historical Dynamics, Organizational Behavior, Social Psychology, Social-Environmental Decision-Making)
- Public Policy (Equity and Justice, Governance, Infrastructure, Political Science, Social

Welfare, Urban Dynamics)

- Stakeholder Engagement (Community Outreach, Group Model Building, Participatory Activities)
- Security, Stability, and Resilience (Conflict, Defense, and Military, Crime and Policing, Cybersecurity and Disinformation, Disaster Management, Food-Energy-Water Security)
- Transport and Mobility (Accessibility and Equity, Decarbonization and Sustainability, Freight and Logistics, Infrastructure Planning and Policy Design, New Technologies and Services, Non-Car and Multi-Modal Transport, Public Health and Traffic Safety)

There are also 26 planned <u>workshops</u> that will be held on either 30 July (online) or 8 August (Bergen and online). A sample of these workshops includes:

- Anti-Agile Tetris How To Make Systemic Change
- Getting Started with Vensim
- Introduction to Virtual Experience (VEx) Design
- Learn to Use ADMO to Analyze Problems in Nonlinear, Dynamic Models with Exogenous Variables
- Projecting Uncertainty with Stella
- Teaching Loop Dominance Analysis and Leverage Point Identification in the Classroom Using Loops That Matter
- The Group Juggle: A Quick Intro to System Dynamics

A Modeling Assistance Workshop will also be available during the conference to provide guidance on problem articulation, dynamic hypothesis, model formulation, model testing, or policy design and evaluation to attendees who sign up for this learning opportunity in advance.

Check <u>here</u> for additional details on the conference schedule.

Learn more about ISDC 2024 <u>here</u>. <u>Register</u> for ISDC 2024.

In conjunction with ISDC 2024, the Student Chapter of the SDS will host a two-day free event, the <u>Student-Organized Colloquium (SOC)</u>. The SOC will take place in two parts:

- Day 1: An online session on 31 July 2024, the week before ISDC.
- Day 2: An in-person session on 4 August in Bergen, the first day of ISDC.

The SOC provides an opportunity for less experienced modelers (e.g. doctoral, master, and undergraduate students, as well as practitioners, professionals, and academics who are new to system dynamics) to discuss System Dynamics related ideas and concerns, share their work with others, and receive feedback from more experienced modelers.

Call for Abstracts: AI4SE & SE4AI Research and Application Workshop



AI

The <u>Systems Engineering Research Center (SERC)</u> will host the <u>AI4SE & SE4AI Research and Application Workshop</u> on 17-18 September at George Mason University in Arlington, Virginia, USA.

The theme of this workshop is Safer AI-Enabled Complex Systems: Responsible Deployment of AI through Systems Engineering.

The <u>Call for Abstracts</u> seeks abstracts from government, industry and academia for presentations and panels to explore the exciting advancements and challenges in the field of artificial intelligence (AI) and systems engineering (SE). Topics of interest include:

- SE4AI: Leveraging systems engineering principles and methodologies to develop safe, robust, and efficient AI systems, while extending them in response to the nature of AI enabled systems.
- AI4SE: Application of AI in support of systems engineering processes, by enabling enhanced decision-making, optimization, validation, and verification.

Abstracts are due by 10 June. All abstracts and presentations must be cleared for public release; participation is limited to U.S. citizens.

Submit abstracts here.

Call for Papers: 1st International Conference on Engineering Digital Twins (EDTconf2024)



A <u>Call for Papers</u> has been issued for the <u>1st International Conference</u> on <u>Engineering Digital Twins (EDTconf2024)</u>. EDTconf2024 will be held on 23-24 September 2024 at Johannes Kepler University in Linz, Austria and will be co-located with the <u>Models 2024</u> conference. This

conference seeks to engage researchers and practitioners on Digital Twins (DTs), from both academia and industry, and from different engineering disciplines and application domains to shape the future of systematically designing, developing, deploying, evolving, maintaining, and validating DTs.

Topics of interest include:

- Modeling concepts and languages, methods, and tools for developing DTs
- DevOps for DTs/DTs for DevOps
- Quality assurance for and evaluation of DTs
- DT modeling, simulation, and co-simulation of CPS
- Deployment and operation of DTs
- Model consistency, management, and evolution of engineering models
- Uncertainty and fidelity in DTs
- DT reliability, trust, and security
- Architectural patterns for DTs
- Virtual commissioning based on DTs
- DTs for continual learning and continuous improvement
- Combining models and data in DTs
- DTs for dynamic (re)configuration and optimization
- Evolution and compositionality of DTs
- Teaching and education of DT skills
- Case studies, experience reports, comparisons in various application domains

The conference seeks submissions, both academic and industrial, in the following categories:

- Regular papers (max 10+2 pages): Present novel research on the model-based engineering of DTs.
- Short papers (4–6 pages): Forward-looking papers about ideas that will interest the conference attendees, e.g., new research avenues, interesting positions, or visions on the future.
- Tool demonstration papers (2–4 pages): Focus on the tooling aspects of engineering DTs.
- Exemplar papers (4–6 pages): Implementations or detailed specifications of DTs in different application domains.

Important dates:

- Abstract submission deadlines: 19 June
- Paper submission deadline: 24 June
- Notification of acceptance: 29 July
- Camera-ready version deadline: 19 August

Accepted papers will be published through the proceedings of the MODELS conference, with selected submissions eligible to be extended and published in the <u>Journal on Software and Systems Modeling</u> (SoSyM).

Register for EDTconf2024 through the <u>MODELS 2024 website</u>.

Call for Papers: International Conference on System Simulation (SIMUL 2024)



The International Academy, Research and Industry Association (IARA) is hosting the Sixteenth International Conference on Advances in System Simulation (SIMUL 2024) on 29 September through 3 October in Venice, Italy, with a virtual participation option. The Call for Papers for this conference has been issued with an initial deadline of 17 June for all submissions.

SIMUL 2024 continues a series of events focusing on advances in simulation techniques and systems providing new simulation capabilities. SIMUL 2024 identifies specific needs for ontology of models, mechanisms, and methodologies to simplify an appropriate tool selection. Submissions of interest include those that address the social and human-in simulation challenges associated with the advent of Web Services and WEB 3.0, along with more classical process simulations and distributed and parallel simulations.

Academic, research, and industrial contributions are sought. Contribution types include:

- regular papers [in the proceedings, digital library]
- short papers (work in progress) [in the proceedings, digital library]
- ideas: two pages [in the proceedings, digital library]
- extended abstracts: two pages [in the proceedings, digital library]
- posters: two pages [in the proceedings, digital library]
- posters: slide only [slide-deck posted on www.iaria.org]
- presentations: slide only [slide-deck posted on www.iaria.org]
- demos: two pages [posted on www.iaria.org]

SIMUL 2024 conference tracks include:

- Building simulation
- Case studies on social simulation
- Distributed simulation
- Experience report on ready-touse tools
- Human-in simulation
- Model based system prediction
- Online social simulation
- Practical applications on process simulations

- Sensitivity analysis
- Simulation mechanisms
- Simulation methodologies
- Simulation models
- Simulations in advanced environments
- Simulation tools and platforms
- Transport simulation
- Trends and achievements
- Warfare simulation
- •

Extended versions of selected papers will be published in <u>IARIA Journals.</u> Articles will be archived in the free access <u>ThinkMind Digital Library</u>.

Submit content <u>here</u>.

Capella Days 2024: Call for Proposals



The annual free online gathering of the Capella (MBSE tool) and Arcadia (MBSE method) community, Capella Days 2024, is scheduled for 19-21 November. Capella Days bring together the creators of Capella/Arcadia,

providers of Capella add-on and services, and MBSE experts and industrial users.

A <u>Call for Proposals</u> has been issued, seeking feedback from industrial users concerning their application of Capella. Topics of interest for these online presentations include:

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

The early submission deadline is 18 August; final submission is due on 9 September. The final program will be announced on 19 September.

Learn more. Submit your talk.

Systems Engineering and Artificial Intelligence:

Evolution, Challenges & Application

by René King

Project Performance International

Copyright © 2024 by Project Performance International. All rights reserved.

Authored for PPI SyEN

1. Introduction

The rapid integration of Artificial Intelligence (AI) in systems engineering (SE) offers an opportunity to reflect on the evolution of AI, the underlying principles for its application, and the wide range of areas where it can be included. Since its inception in the 1950s, AI has aimed to replicate human intelligence in machines, focusing on capabilities such as data processing, pattern recognition, problem-solving, and autonomous decision-making (Smith & Roberts, 2022). AI encompasses a diverse array of technologies and methodologies, including systems with predefined decision-making logic and those capable of learning from data. Machine Learning (ML) is a key area of focus in modern AI applications.

Al is perceived not as a substitute for SE practitioners but as a valuable tool that enhances their capabilities and alleviates the workload of repetitive tasks. It also paves the way for novel innovations and improves various industrial processes. Engineers face the challenge of harnessing these advanced technologies, optimizing their potential, and persisting in leading the development of adaptive solutions that meet the changing demands of society (Smith et al., 2023).

Key AI technologies integral to SE include:

1. Machine Learning (ML): ML empowers systems to learn from experience and improve autonomously without being explicitly programmed. This technology is particularly advantageous for applications like predictive analytics, anomaly detection, and system optimization. ML derives its core principles from statistics and computer science, bolstered by advancements in computational power and memory capabilities of modern hardware like CPUs and GPUs (Johnson, 2021). ML can be categorized into three primary learning models:

- Supervised Learning: This model utilizes labeled datasets to learn the mapping between input and output pairs, which can be applied in scenarios like image recognition from labeled images (Lee & Kim, 2021).
- Unsupervised Learning: In this model, algorithms learn to identify patterns or group data

without prior labeling, useful in tasks such as customer segmentation or fraud detection (Brown & Patel, 2022).

• Reinforcement Learning: This involves training an AI agent to make decisions that result in a positive outcome based on a defined reward system, such as navigating robots through obstacles (O'Neil, 2022).

2. Neural Networks: Mimicking the structure and function of the human brain, neural networks provide advanced pattern recognition and decision-making capabilities paramount for complex system simulations and data-intensive tasks (Garcia, 2022).

3. Natural Language Processing (NLP): NLP allows systems to understand and interpret human language, facilitating enhanced communication between humans and machines, essential for gathering requirements and documentation processes (Jurafsky & Martin, 2020).

2. Integrating Systems Engineering with Digital Transformation

The transdisciplinary approach of SE is increasingly intersecting with the expansive fields of digital transformation—namely big data, cloud computing, AI, and the Internet of Things (IoT). This integration is revolutionizing how organizations enhance their business and operational models by leveraging vast data accumulations concerning their operations, systems, customers, and employees. The exponential growth in data has driven the necessity for AI-driven solutions, which are bolstered by significant advancements in computational power and storage capabilities (Smith et al., 2020).

For SE practitioners, proficiency in navigating the digital transformation ecosystem is becoming essential. This ecosystem encompasses collaboration with a range of specialists including data scientists, AI engineers, cloud computing experts, and application developers. The comprehensive understanding of these domains enables SE practitioners to effectively contribute to their organizations by pinpointing areas where AI can be most beneficial (Johnson & Marquez, 2021).

Moreover, SE practitioners need to grasp the full spectrum of AI development, from identifying system requirements and designing architectures to selecting the appropriate technology stack, development platforms, and other SE activities relevant to the engineering of any type of system, including those involving AI. This is important for identifying the most effective AI applications and avoiding the pitfalls that can accompany AI initiatives (Lee & Kim, 2021). As the AI field evolves rapidly, the differentiation of roles between SE and AI-specific professionals like data scientists and AI engineers becomes more pronounced. The dynamic nature of AI technology means that companies often opt to license existing AI models or purchase ready-to-implement solutions rather than developing in-house capabilities, which may involve significant investment and upkeep (Brown & Patel, 2022).

Additionally, there are emerging unified platforms designed to standardize AI application workflows, equipped with the necessary technology stacks for data collection, labeling, and integration into machine learning models. These platforms simplify the process of AI application development and are increasingly used in industry settings (O'Neil, 2022).

In this evolving landscape, the role of the SE practitioner is not to mirror the deep technical expertise of data scientists but to develop a functional understanding of the technologies that underpin Al applications. This includes familiarity with data integration techniques, both relational and non-relational databases, cloud storage solutions, enterprise architecture infrastructures, APIs, machine learning frameworks, and the processing environments necessary for AI deployment. Knowledge of May 2024 [Contents] 26

commonly used programming languages, along with UI and data visualization tools, also plays a critical role in the effective application of AI solutions in SE (Garcia, 2022).

3. The Evolving Role of AI in Industry and Systems Engineering

The landscape of AI in industry and SE has experienced significant growth over the past decades. Machine learning (ML) solutions have become pivotal in both technical and social systems, driving new business opportunities and models. The rapid commercialization of AI technologies is catalyzing profound changes across all market sectors, positioning AI as a key component for achieving corporate objectives (Smith et al., 2020).

Widespread AI Integration Across Industries

Organizations across every industry are integrating AI to enhance various layers of enterprise operations. AI solutions are being applied extensively in domains such as sales, security, human resources, marketing, finance, and more. For instance, companies like Amazon and Netflix utilize AI for dynamic recommendations and price optimization, significantly enhancing consumer engagement and business performance (HBR, 2018). Similarly, AI applications in cybersecurity, such as breach risk prediction and cyber threat classification, are becoming essential for maintaining data integrity (IBM Case Studies).

Al is revolutionizing various sectors by enhancing efficiency, reducing costs, and improving outcomes through its advanced capabilities in data processing and decision-making. From aerospace to healthcare, Al's integration into different industries demonstrates its transformative impact and potential for future advancements. Here are several key areas where Al is making significant strides:

- Aerospace System Design and Testing: NASA is utilizing AI technologies to optimize spacecraft design and testing processes. This integration has not only reduced prototyping time and costs but also enhanced the accuracy of failure predictions during testing phases.
- Autonomous Vehicle Systems: Companies like Tesla and Waymo are at the forefront of refining autonomous vehicle systems using Al. By processing real-time data from vehicle sensors, these companies are significantly improving navigation decisions, thereby enhancing both safety and operational efficiency.
- Smart Manufacturing and Robotics: In the manufacturing sector, giants such as Siemens and General Electric are employing AI to streamline production processes and improve quality control. AI-driven robots in these environments are designed to adapt to changes, thus boosting both efficiency and precision in production.
- Energy Systems Optimization: Al is also being used to optimize energy distribution systems by companies like General Electric and various utility providers. Through efficient resource management and the integration of renewable energy sources, Al is enhancing the reliability of these energy systems.
- Healthcare Infrastructure: In the healthcare sector, AI is revolutionizing management practices by analyzing patient data to optimize staffing, improve patient flow, and enhance the overall quality of care. This results in more effective healthcare delivery and improved patient outcomes.

These examples highlight the role of AI as a technology pivotal in engineering the future of industriesby providing solutions that are not only innovative but also sustainable and efficient.May 2024[Contents]27

Navigating Challenges and Seizing Opportunities in AI for SE

The integration of AI into systems engineering has brought about transformative changes, enhancing the efficiency and effectiveness of various stages in the SE lifecycle. In the requirement analysis phase, AI tools are used for extracting and analyzing detailed system requirements, thus providing a clearer and more accurate understanding of project needs from the outset (Chen, 2020). During the design and simulation stage, AI-driven tools such as digital twins facilitate detailed simulations and scenario testing, significantly improving design accuracy and efficiency (Morgan & Lee, 2021).

In the verification and validation phase, AI enhances testing procedures, enabling more effective system verifications and reliability assessments through predictive behavior analysis (O'Neil, 2022). For operation and maintenance, AI is utilized through predictive maintenance tools that anticipate and mitigate potential system failures, thereby optimizing maintenance schedules and reducing downtime (Garcia, 2022). Looking ahead, AI in SE is set to focus more on enhancing early development stages such as requirements analysis, process modeling, and project planning. These areas, often constrained by traditional tools, present significant opportunities for AI to make substantial contributions (Smith et al., 2020).

Despite its widespread adoption, integrating AI poses several challenges that require robust system architectures to maximize the utility of digital products and services. The main challenges include managing data quality, handling the complexity of AI algorithms, and integrating AI into existing systems. Poor data quality can significantly undermine AI performance, resulting in inaccurate models and flawed decisions. AI algorithms demand substantial computational resources and a deep understanding of both AI and engineering principles, complicating both implementation and maintenance. Furthermore, merging AI with existing engineering processes and legacy systems requires careful consideration of compatibility and potential impacts on established workflows (Kumar & Singh, 2022).

Additionally, ethical and social challenges such as biases in AI systems, accountability for AI-driven decisions, and the impact of automation on jobs need addressing. It is essential to mitigate biases to prevent them from influencing AI models and decision-making processes. Establishing clear accountability, especially in high-stakes engineering applications, is essential. Concerns about AI automating tasks and impacting employment highlight the need for AI to augment rather than replace human skills (Li et al., 2023).

Effective strategies to address these challenges include continuous education and training, establishing clear ethical guidelines, and fostering AI-human collaboration. Ongoing training ensures that SE practitioners stay current with evolving AI technologies. Ethical guidelines should promote fairness, transparency, and accountability in AI applications. Encouraging collaborative models that combine AI capabilities with human expertise can lead to more efficient and effective systems engineering outcomes (Taylor, 2021).

While the integration of AI into SE presents multiple challenges, it also opens up numerous opportunities. By addressing these challenges and effectively leveraging AI's capabilities, SE can harness AI to significantly enhance processes and outcomes, leading to increased efficiency, reduced costs, and improved system reliability.

Strategic Recommendations for Integrating AI in Model-Based Systems Engineering

(drawn from the paper: Artificial Intelligence Capabilities for Effective Model-Based Systems Engineering: A Vision Paper by Mohammad Chami, Nabil Abdoun, Jean-Michel Bruel)

- Enhance Knowledge Acquisition: Employ AI4MBSE to facilitate the elicitation, analysis, extraction, and validation of domain expertise through advanced knowledge acquisition techniques, supported by formal systems modeling and ontologies.
- Manage AI Tasks Proactively: Implement control mechanisms within AI4MBSE tools to actively manage and monitor AI tasks, ensuring rapid response capabilities for any unexpected outcomes to maintain system reliability.
- Implement Optional AI Automation: Consider the selective automation of specific SE tasks through AI4MBSE, with a focus on rigorous testing and validation before these systems are fully deployed.
- Update Educational Frameworks: Integrate AI methodologies and principles into the MBSE curriculum at universities and training centers to prepare future SE practitioners with the necessary skills to leverage AI effectively.
- Utilize Ontological Structures: Support AI4MBSE with a comprehensive ontology that defines the elements of modeling languages and AI interactions to promote effective and coherent application of AI technologies.
- Expand Modeling Techniques: Extend traditional MBSE modeling methods to include Al development and deployment steps, seamlessly incorporating Al functionalities into systems engineering workflows.
- Enhance Querying Capabilities: Develop and implement sophisticated semantic querying techniques within AI4MBSE to enable SE practitioners to easily access and interrogate model content, facilitating informed decision-making.
- Improve Visualization Tools: Ensure that AI4MBSE tools are equipped with advanced visualization capabilities that allow for the graphical representation of models, enhancing clarity and understanding of complex information.
- Recognize AI Limitations: Acknowledge that while AI4MBSE offers substantial benefits, it does not solve all MBSE challenges. Utilize early experiences with AI4MBSE to strategically allocate AI capabilities where they can most effectively address specific MBSE challenges.

These suggestions aim to guide the successful integration of AI into MBSE practices, enhancing the capability, efficiency, and effectiveness of SE efforts through strategic use of AI tools and techniques.

4. Applications of Systems Engineering in Artificial Intelligence

Systems Engineering for Artificial Intelligence (SE4AI) involves applying SE principles and methodologies specifically to the design, development, and implementation of artificial intelligence systems. SE4AI emphasizes structuring and managing AI projects with a focus on ensuring that these systems are reliable, scalable, and efficient. The primary objective of SE4AI is to integrate AI systems effectively within broader systems and organizational frameworks, ensuring technical soundness and operational harmony.

A critical aspect of SE4AI is to guarantee that AI systems perform as anticipated and meet user requirements, which is achieved through rigorous verification and validation processes. However, AI systems often present unique failure modes that traditional SE life cycle approaches do not sufficiently address. This challenge necessitates the formulation of specialized methods tailored for May 2024 [Contents] 29

engineering AI systems that are capable of adaptive and intelligent behavior, ensuring that these systems can handle real-world complexities and dynamics effectively (Smith & Roberts, 2022). Key challenges include:

- New Failure Modes: Al introduces novel failure modes that are unprecedented in traditional systems engineering. These include negative side effects, reward hacking, scalable oversight, unsafe exploration, and distributional shifts. Addressing these new challenges necessitates the development of innovative safety protocols and monitoring strategies to ensure that Al systems operate safely and as intended.
- Performance Predictability: AI systems, especially those utilizing machine learning, often exhibit non-deterministic and evolving behavior. This unpredictability challenges the verification of system compliance with specifications before deployment. As these systems continuously learn from new data, their performance may alter, complicating the prediction of behavior and the assurance of system reliability (Johnson, 2021).
- Trust and Explainability: The process of verifying AI systems typically involves comparing test results with expected outcomes and relying on expert judgment to assess compliance acceptability. However, the lack of explainability in certain AI behaviors adds complexity to this process, making it challenging to establish trust and ensure robust future performance.

In addition to addressing these challenges, the successful deployment of AI technologies heavily relies on effective systems integration. SE plays a crucial role in integrating AI into broader system architectures, ensuring that AI components are compatible and functional within existing frameworks. This integration is essential for designing AI systems that are not only intelligent but also robust, reliable, and scalable.

Furthermore, quality assurance and risk management are vital components where SE can make a significant impact. By applying SE principles, engineers can identify potential risks at the early stages of AI development and devise strategies to mitigate these risks, thereby enhancing the safety and reliability of AI applications (Johnson, 2021).

To overcome these challenges, there is a need for a concerted effort to adapt SE methodologies to the unique characteristics of AI technologies. This adaptation will ensure that AI systems are effectively and safely deployed across diverse applications, maintaining high standards of performance and safety.

Below are examples of how SE principles are being applied in three key domains to harness the potential of AI and address the unique challenges each sector faces.

- Autonomous Vehicles: In the automotive industry, SE principles are instrumental in developing and refining autonomous driving technologies. SE methodologies facilitate the integration of various AI components, such as sensors, navigation systems, and decision-making algorithms, ensuring that autonomous vehicles operate safely in complex environments.
- Healthcare AI Systems: SE is equally critical in the healthcare sector, particularly in the development of AI applications such as diagnostic systems, patient management systems, and robotic surgery. By adhering to medical standards and regulations, SE ensures that these AI systems integrate seamlessly with existing healthcare workflows, thus enhancing patient care and operational efficiency.

• Smart Manufacturing: In the manufacturing sector, SE supports the deployment of Al technologies for predictive maintenance, quality control, and supply chain optimization. Through SE frameworks, AI is effectively embedded into manufacturing processes, which enhances efficiency and reduces downtime, leading to significant improvements in productivity and cost reduction.

Integrating AI with SE presents several challenges due to the dynamic nature of AI systems, rapid technological advancements, and the complexities involved in merging AI with existing systems engineering frameworks.

- Complexity in Requirements: Al systems are characterized by dynamic and complex requirements that are difficult to manage with traditional SE approaches. The iterative development nature of Al, particularly with machine learning models that evolve with new data, poses a significant challenge to the static processes typically used in SE (Lee & Kim, 2021).
- Technological Pace: The swift progression of AI technology frequently outpaces the slower, more systematic procedures of conventional SE. Keeping up with AI innovation while guaranteeing comprehensive testing and validation poses an ongoing challenge (Jones et al., 2022).
- Integration with Existing Systems: Incorporating AI into established SE frameworks often requires substantial modifications to existing processes and infrastructure, making integration efforts resource-intensive and complex (Sheikh, 2024).

Despite these challenges, the future of SE influenced by AI looks promising with several prospects:

- Improved SE Techniques in AI: With the increasing integration of AI into diverse industries, software engineering practices are undergoing transformations to cater to the distinctive requirements of AI technologies. This adaptation encompasses the formulation of novel, adaptable, and iterative approaches that resonate more closely with the agile methodologies commonly utilized in AI ventures (Smith et al., 2023).
- Cross-disciplinary Training: Scholars have noted a growing emphasis on cross-disciplinary training initiatives aimed at engineers, integrating both AI and SE expertise. This educational strategy is designed to equip professionals with the skills necessary to adeptly address the complexities inherent in contemporary intelligent systems (Smith & Johnson, 2023).

Overall, the integration of AI into SE is transforming the design, implementation, and maintenance of intelligent systems. While challenges remain, the ongoing evolution of SE practices and strategic workforce training are paving the way towards more robust, efficient, and reliable AI systems. As both fields continue to evolve, the synergy between systems engineering and AI is poised to drive significant technological advancements and innovation across various industries.

References:

Brown, A., & Patel, R. (2022). Reinforcement Learning: Concepts and Methods. Machine Learning Journal, 30(2), 221-235.

Chami, M., Abdoun, N., & Bruel, J. (2022). Artificial Intelligence Capabilities for Effective Model-Based Systems Engineering: A Vision Paper. INCOSE International Symposium, 32(1), 1160–1174. May 2024 [Contents]

https://doi.org/10.1002/iis2.12988

Chen, W. (2020). Challenges and Opportunities in Al-Driven Systems Engineering. Systems Engineering Journal, 15(3), 456-470.

Garcia, M. (2022). Neural Networks: Architectures and Applications. Journal of Neural Computing, 15(1), 78-92.

IBM Case Studies. (2023). Cybersecurity Solutions Powered by AI. Retrieved from: https://www.ibm.com/ai-cybersecurity

Johnson, R. (2021). Machine Learning: Principles and Applications in Artificial Intelligence. Journal of Artificial Intelligence Research, 17(2), 45-56.

Johnson, R., & Marquez, S. (2021). Integrating Systems Engineering with Digital Transformation. Journal of Digital Engineering, 8(2), 210-225.

Jones, A., Smith, B., & Johnson, C. (2022). "Navigating the Rapid Progression of AI Technology in Systems Engineering." Journal of Engineering Innovation, 15(3), 45-62.

Jurafsky, D., & Martin, J. H. (2020). Speech and Language Processing (3rd ed.). Pearson. Kumar, A., & Singh, R. (2022). Managing Data Quality Challenges in AI Integration. Data Management Journal, 28(2), 321-335.

Lee, H., & Kim, S. (2021). Unsupervised Learning: Algorithms and Applications. IEEE Transactions on Pattern Analysis and Machine Intelligence, 25(4), 789-802.

Li, H., et al. (2023). Ethical and Social Implications of AI Integration in Systems Engineering. Journal of Ethics in Technology, 10(1), 145-160.

Morgan, T., & Lee, S. (2021). Al-driven Tools for Design and Simulation in Systems Engineering. Journal of Simulation, 20(4), 567-580.

NASA. (2021). Al for Space and Aerospace. Retrieved from: https://ntrs.nasa.gov/api/citations/20210022097/downloads/AI%20in%20Aerospace%201.pdf Sheikh, A. (2024, March 8). The Evolution of Systems Engineering with Al Integration: A New Era of Innovation and Efficiency. Retrieved from: https://www.linkedin.com/pulse/evolution-systemsengineering-ai-integration-new-era-arif-sheikh-1apwe/

Siemens. (2024). Al in Smart Manufacturing. Retrieved from: https://blogs.sw.siemens.com/opcenter/the-future-of-manufacturing-how-ai-smart-manufacturingsolutions-sustainability-initiatives-and-global-partnerships-will-shape-2024/

Smith, J., & Roberts, L. (2022). Artificial Intelligence Capabilities for Effective Model-Based Systems Engineering: A Vision Paper. INCOSE International Symposium, 32(1), 1160–1174. https://doi.org/10.1002/iis2.12988

Smith, J., & Roberts, L. (2022). Systems Engineering & Artificial Intelligence. Journal of Systems Engineering, 5(3), 112-129. May 2024 [Contents]

Smith, J., Brown, M., & Johnson, D. (2023). "The Role of AI as a Tool in Systems Engineering: Challenges and Opportunities." Journal of Industrial Engineering, 18(2), 77-94.

Taylor, K. (2021). Al-human Collaboration in Systems Engineering. Journal of Human-Machine Interaction, 8(3), 410-425.

About the Author



René King is a Senior Engineer and Business Development Manager at Project Performance International (PPI). She holds a BSc in Mechanical Engineering and an MSc in Systems Engineering, both from the University of Witwatersrand in South Africa. Her master's thesis focused on evaluating the operational capacity of a freight railway network by integrating multiple analytical frameworks to maximize efficiency with fixed resource inputs. Additionally, René is the Managing Director of PPI's subsidiary, Certification Training International, and leads the PPI-INCOSE Systems Engineering Tools Database

project. This collaborative initiative aims to assist engineers in finding tools that enhance their systems engineering activities. Certified as ASEP and SE-ZERT Level C, René is deeply committed to the value of certification in expanding the reach of systems engineering. She is dedicated to exploring ways in which PPI and CTI can better support individuals, teams, and organizations in addressing the engineering challenges of the future.

P006-939	Eindhoven, the Netherlands CEST 8:30 (UTC +2:00) In-Person	10 Jun – 14 Jun 2024
P006-940	Las Vegas, USA PDT 8:00 (UTC -7:00) In-Person	17 Jun – 21 Jun 2024
P006-941-1	Asia SGT 6:00 (UTC +8:00) PPI Live-Online™	24 Jun – 28 Jun 2024
P006-941-2	Oceania AEST 8:00 (UTC +10:00) PPI Live-Online™	24 Jun – 28 Jun 2024
P006-942	London, United Kingdom BST 8:30 (UTC +1:00) In-Person	29 Jul – 02 Aug 2024
P006-943-1	North America MDT 8:00 (UTC -6:00) PPI Live-Online™	29 Jul – 02 Aug 2024
P006-943-2	South America BRT 11:00 (UTC -3:00) PPI Live-Online™ (Exclusive to South America)	29 Jul – 02 Aug 2024
P006-944	Las Vegas, USA PDT 8:00 (UTC -7:00) In-Person	05 Aug – 09 Aug 2024
P006-945-1	Asia SGT 6:00 (UTC +8:00) PPI Live-Online™	19 Aug – 23 Aug 2024
P006-945-2	Oceania AEST 8:00 (UTC +10:00) PPI Live-Online™	19 Aug – 23 Aug 2024
P006-946-1	Europe CEST 9:00 (UTC +2:00) PPI Live-Online™	23 Sep – 27 Sep 2024

Upcoming PPI Live-Online [™] and In-Person Systems Engineering Five Day Courses

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

Useful artifacts to improve your SE effectiveness

INCOSE INSIGHT Practitioners Magazine: Advancing Systems Engineering in the Face of Complexity



The April 2024 edition (Volume 27, Issue 2) of INSIGHT, INCOSE's Practitioner Magazine published by Wiley, has been released. Electronic subscriptions to INSIGHT are available as a member benefit to INCOSE

members. Hard-copy subscriptions to INSIGHT are available for purchase by INCOSE members for one membership year, and to the public.

The focus of this issue is *Advancing Systems Engineering in the Face of Complexity*. Contents of this 40-page resource include:

Systems Engineering and the Pursuit of Elegance: A Transdisciplinary Approach to Complex Problems by Michael Pennotti, Peter Brook, and David Rousseau

In an increasingly complex landscape of advanced technologies, the question of how systems engineering can retain its relevance is more pertinent than ever. Originating with a pragmatic focus on achieving technical objectives, systems engineering has shifted towards process and methodology. We argue, however, that it's time for this discipline to return to its roots and embrace its nature as a transdiscipline. Transdisciplinarity is not just a characteristic of systems engineering; it's necessary for devising elegant solutions to today's complex challenges. In this article, we present a comprehensive framework around the nature of systems engineering, detailing its principles, methods, and purposes. This framework demonstrates how systems engineering is linked to numerous disciplines and social institutions, showcasing its multifaceted impact. By understanding and using this framework as a lens on the discipline, we can foster a common recognition of systems engineering's value, ensuring its continued significance in a rapidly evolving world.

Advancing System Engineering's Relevance in a Changing World

by Peter Brook, Michael Pennotti, and David Rousseau

The future value of systems engineering may well be measured by its contribution to INCOSE's vision of "a better world through a systems approach." To stay relevant, systems engineering must expand its scope beyond the technical realm by addressing today's most pressing and complex problems, which span technical, social, and ecological domains. This paper builds on our previous work on the evolving architecture of the systems engineering discipline, detailing how it can maintain its value by effectively engaging in eco-socio-technical challenges. We propose collaborative strategies with other disciplines to enhance and broaden its foundational base, which will be crucial for realizing its potential as a transdisciplinary field in an increasingly complex world.

Five Perspectives on Transdisciplinary Systems Engineering

by Peter Brook, Azad M. Madni, Michael Pennotti, David Rousseau, and Hillary Sillito

This article offers insights from five INCOSE Fellows on the evolution and significance of transdisciplinarity in systems engineering. Michael Pennotti reviews the origins of systems engineering, emphasizing its inherent transdisciplinary nature and the need for continuous evolution. Azad Madni considers transdisciplinarity as systems engineering's true calling, crucial for the 21st century, and highlights his TRASEE™ education paradigm that underpins the Systems Architecting and Engineering program that he directs at the University of Southern California as pivotal for systems engineering's advancement. Hillary Sillitto sees the climate crisis as systems engineering's most critical and complex challenge, asserting transdisciplinarity's crucial role in addressing it. David Rousseau examines the cultural and scientific underpinnings of transdisciplinarity, presenting systems engineering as a prime example. Peter Brook envisions the joint evolution of systems sciences and systems engineering to confront future challenges, advocating for transdisciplinarity as an essential role in systems engineering to addressing leadership for addressing global challenges.

The Spectrum and Evolution of Systems Engineering's Guiding Propositions by David Rousseau, Michael Pennotti, and Peter Brook

Systems engineering has numerous guiding propositions scattered across various publications and classified under different schema, leading to confusion and inconsistency. This paper presents a framework for understanding the origin and evolution of any guiding proposition and developing such a guiding proposition into a principle to meet the challenges of Industry 4.0 and Society 5.0. We argue that following this process will enhance the elegance and transdisciplinary value of systems engineering principles and aid in solving complex problems.

Transitioning Science to Practice

by Stuart D. Harshbarger and Rosa R. Heckle

National security challenges require a new approach to collaborative problem solving to address emergent challenges or opportunities. To effectively address these challenges, development of artificial intelligence (AI) technologies including machine learning (ML) and deep learning (DL), is underway. Advancing AI/ML capabilities requires transdisciplinary research encompassing the fusion of technology and emergent scientific discovery. Achieving this requires a departure from traditional research and development (R&D) methods. New development processes need to support the understanding that research progresses iteratively, technology insertion is incremental, and the final capability is evolutionary. We propose a novel systems engineering/research model called the vortical model. The vortical model introduces an iterative framework through which emerging advances in research outcomes are effectively demonstrated and validated for integration, as new capabilities, at varying technology insertion points. Our goal is to facilitate the transfer of knowledge from emerging research for swift, effective integration into the organization's mission capabilities.

Join INCOSE <u>here</u> to access this rich systems engineering resource.

<u>Download</u> INSIGHT Volume 27, Issue 2 from the INCOSE iNet. View this issue in the <u>Wiley online library</u>.

Highlighted System Dynamics Resources



The System Dynamics Society (SDS) has recently highlighted the capabilities of a variety of system dynamics resources. PPI SyEN readers are encouraged to investigate the utility of these tools and concepts.

<u>A Design Value Calculator: A System Dynamics Boardgame</u>

Entrepreneurs face a multitude of challenges when it comes to product design, ranging from understanding user needs to navigating technical constraints. One of the primary hurdles is identifying and addressing the true pain points of their target audience. Without a deep understanding of user behavior, preferences, and expectations, entrepreneurs risk developing products that fail to resonate with their intended market.

To address this, the CzechInvest Agency developed an interactive board game powered by a System Dynamics model simulator that simulates the economic development of a company over six years and calculates the profitability of changes made to the product design. Investments may be varied and outcomes evaluated across five areas of innovation:

- Services
- Marketing methods
- Customer Relationships
- Goods and products
- Internal Company Processes

Explore the <u>Design Value Calculator</u>.

Engaged Decision Making - From Team Knowledge to Team Decisions

This new, open access e-book by Etiënne A. J. A. Rouwette and L. Alberto Franco, published by Taylor & Francis, addresses the central role that teams play in decisions made within and across organizations. The authors draw from psychology, decision science, systems science, and decades of consulting experience to show how designed interventions can enable team decision-making to become rigorous, transparent, and defensible. Content includes:

- <u>1. Decision making traps</u>
- <u>2. Motivated team decision making</u>
- <u>3. Interventions to support team decisions</u>
- <u>4. Group model building</u>
- <u>5. Application Building the business model of Sioo management education</u>
- <u>6. Participatory scenario development</u>
- <u>7. Application Understanding possible futures of Nijmegen municipality</u>
- <u>8. Group causal mapping</u>
- <u>9. Application Prioritizing projects to tackle teenage pregnancies in a multi-cultural</u> neighborhood (part I)
- <u>10. Decision conferencing</u>
- <u>11. Application Prioritizing projects to tackle teenage pregnancies in a multi-cultural</u> <u>neighbourhood (part II)</u>
- <u>12. Design Choices</u>
- <u>13. Basics of facilitation</u>
- <u>14. Managing process and content</u>

- <u>15. Managing conflict and emotion</u>
- 16. Are interventions used in practice and do they really work?
- <u>17. Building skills for the study and practice of interventions</u>

Teaching Systems Thinking to Kids – Billibonk Book Resources

The Billibonk and Frankl book series is a collection of jungle-based fables that showcase principles of systems thinking through the experiences of various animal characters. The stories are engaging and relatable to both children and adults, while demonstrating how different species in the jungle learn to collaborate and solve problems together. Four books make up the series:

- Billibonk and the Thorn Patch
- Billibonk and the Bugs
- The Floods of Knith
- <u>The Dark Jungle</u>

Each book is accompanied by a downloadable poster and explanatory videos narrated by the author, Philip Ramsey.

Multisolving Institute YouTube Channel



The <u>Multisolving Institute</u> defines multisolving as "when one investment of time or money solves many problems at once." To promote access to multisolving resources, the Institute has launched a <u>YouTube channel</u> that features videos from its staff and partners. Topics currently addressed include:

FLOWER: Visualizing Solutions for Equity Climate Health Webinar

This interactive webinar introduces FLOWER, which stands for Framework for Long-term, Wholesystem, Equity-based Reflection. Join us to network alongside people with similar interests, learn about FLOWER and the ways it can support your work, and gain insights about the potential multisolving holds to create systems change. We especially encourage people working across multiple silos in communities, non-profits, businesses, or government to use FLOWER. This includes community leaders, teachers, and systems thinkers. However, the webinar is open to all interested in utilizing the tool.

The Power of Multisolving for People and Climate

Is the way we are thinking about climate change preventing us from solving it? In this TEDxSunValley talk, Elizabeth Sawin tells how we can solve the climate issue by helping other people solve their problems. Elizabeth Sawin is Co-Director of Climate Interactive, a think tank that applies systems analysis to climate change and related issues.

Systems change, Multisolving, and the power to change direction

In this interview with Dr. Elizabeth Sawin, we talk about systems change, Climate Interactive's influence on UN climate conference negotiations, multisolving, the importance of building relationships and networks, the emissions gap, cultural narratives & paradigms, and lots of advice for folks on their climate journeys!

ReThink Health Toolbox: Multisolving

Multisolving is a way of addressing complex challenges by identifying and implementing solutions that

can solve multiple problems at once. Scroll down for a recording of a ReThink Health Toolbox webinar on multisolving. During the webinar, presenters covered an overview of multisolving, discussed what multisolving looks like in practice, and explored how it can be applied to create lasting and transformative change. Participants also heard examples of multisolving solutions, or "multi-solvers," that are being implemented across the U.S.

Subscribe to the Multisolving Institute YouTube channel <u>here</u>.

Siemens Digital Transformation and SE Resources

The Digital Industries Software division of Siemens offers a diverse set of resources that may inform systems engineering practitioners how to accelerate their progress toward digital transformation objectives.

The aerospace and defense executive's guide to realizing digital transformation in systems engineering

This e-book details how implementing a holistic approach to systems engineering can enable help organizations to deliver timely, innovative, and safe aerospace and defense products. Suggested capabilities and practices include:

- Integrating processes across the complete product and lifecycle
- Collaborating seamlessly across domains and stakeholders
- Facilitating early mitigation with multidomain simulations

Access the e-book.

<u>Ten Ways to Win with MBSE for dummies®</u>

This online resource suggests ten lessons learned that may help organizations in their adoption of MBSE. A few of these insights include:

- Transform the Process
- Redefine System Modeling
- Embrace Collaboration
- Tracing Your Way to Success

Accelerating Product Development Through Digital Transformation

This white paper summarizes the business case for digital transformation investments in terms of the need to tame complexity and turn a lengthy design process into one marked by speed and agility. It provides brief defense-related examples of such transformations.

Effective aerospace systems engineering case studies

This web page, albeit its focus on Siemens digital engineering solutions, identifies four case studies that may be instructive to systems engineering practitioners by illustrating common principles of effective MBSE.

- <u>Safran Landing Systems</u> Accurately predicting landing system performance with system simulation
- <u>General Atomics Aeronautical Systems, Inc.</u> Accelerating aircraft design using tool integration and automation

- <u>Bye Aerospace</u> Airplane manufacturer uses Siemens solutions to reduce product development time for all-electric composite aircraft
- <u>Airbus</u> Using model-based systems engineering to develop the next-generation A350 XWB

SAM2023 SDL Forum YouTube Channel



The 15th System Analysis and Modelling conference (SAM2023) took place on 2-3 October 2023 in Västerås, Sweden. SAM2023 highlighted the most recent innovations, trends, experiences and concerns in modeling, specification, analysis, implementation, and monitoring of complex systems using ITU-T's Specification and Description Language (SDL 2010) and Message Sequence Chart (MSC) notations.

The <u>SDL Forum Society</u>, sponsors of SAM2023, have launched a new <u>SDL Forum YouTube channel</u> to make available videos from the conference. Videos currently posted include:

- Automated provenance collection at runtime as a cross-cutting concern
- Language agnostic model checking for SDL
- Program abstraction and re-engineering: an Agile MDE approach
- <u>openCAESAR: Balancing Agility and Rigor in Model-Based Systems Engineering</u>
- <u>Tools for Traceability-based Change Impact Analysis using Domain-specific Modeling</u>
 <u>Approach</u>
- <u>Towards Memory-Efficient Validation of Large XMI Models</u>
- Towards SysML v2 as a Variability Modeling Language
- What your mother forgot to tell you about modeling and programming

These videos range in length from 16 to 44 minutes.

Let's Flow: Ideation, Conceptualization, and Design Thinking in Product Design

A recent addition to the Knowledge Hub (<u>kHUB</u>) of the <u>Product Development</u> <u>Management Association (PDMA)</u> emphasizes the importance of idea management capabilities, the nurturing of creativity and the application of design heuristics in the product innovation process.

The proposed Let's Flow ideation process includes the following innovation flow:

- Sense intent
- Know context
- Know people
- Frame insights
- Explore concepts
- Frame solutions
- Realize offerings

During the Let's Flow process, numerous creativity techniques are used in hands-on workshops to spark creative ideas and develop them to maturity.

FINAL THOUGHTS FROM SYENNA

The Art of Systems Engineering Under Various Guises

Ah, systems engineering—the noble practice of taking complex problems, untangling them from their sticky web of chaos, and systematically solving them. It's a discipline so revered, it's practically the Da Vinci of the engineering world. But hold on to your blueprints and Gantt charts, folks, this sacred principle of systems engineering is masquerading under different names across a myriad of industries, like a master of disguise at a costume party.

The Corporate World: "Management Consulting"

In the corporate jungle, systems engineering takes off its utilitarian hard hat and dons a sleek power suit, rebranding itself as "management consulting." Here, consultants waltz into boardrooms, armed with PowerPoints and buzzwords, to help businesses untangle their operational messes. The process? Identify the problem (profits are down, employees are rioting) and propose a solution (restructure, rebrand, retrain).

Healthcare: "Diagnosis and Treatment"

In the sterile corridors of healthcare, systems engineering is alive and well, albeit under the guise of "diagnosis and treatment." Doctors, those white-coated engineers of the human body, first isolate the problem (the diagnosis). Once they've pinpointed the malady, they swoop in with a solution (treatment).

Education: "Curriculum Development"

Enter the hallowed halls of academia, and you'll see systems engineering cleverly disguised as "curriculum development." Educators and administrators identify the problem (students aren't learning) and then craft elaborate lesson plans and educational strategies to solve it (teach better, test harder, repeat).

Industry: "Product Management"

In the fast-paced world of tech, systems engineering shapeshifts into "product management." Product managers isolate the user's pain points (the problem) and work with engineers and designers to create solutions (apps, features, updates).

Politics: "Policy Making"

Even in the murky waters of politics, systems engineering is at play, albeit cloaked in the noble robe of "policy making." Politicians and their aides identify societal issues (unemployment, healthcare, infrastructure) and devise policies (laws, reforms, budgets) to address them.

It seems that no matter the domain, we're all just humble practitioners of systems engineering, working to make sense of the world's complexities, one problem-solution pair at a time. And isn't that just a little bit comforting? Or perhaps, a tad bit absurd?

Regards, Syenna