PPI SyEN

SYSTEMS ENGINEERING NEWSJOURNAL

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WELCOME

Welcome to this special 100th edition of PPI Systems Engineering Newsjournal!

As I reflect on a milestone such as this, I see a similarity to other milestones such as New Year's Eve: a time when we look back with appreciation, gratitude, and openness to learning; when we look forward with anticipation and resolutions; and when we gather with friends and family to celebrate.

Looking back: PPI SyEN has a lengthy and rich tradition of excellence in bringing news, information, and perspective to the systems-engineering community. Much of that impressive legacy results from the tireless efforts of my predecessor as editor, Dr. Ralph Young, whose shoes I will be endeavoring to fill. Those high standards of quality and value are just as important and as relevant for this 100th edition as they were for the first.

Looking forward: However, the world isn't the same as it was when PPI SyEN first launched. Complexity seems greater, and time seems more scarce, more precious. There are more things to know and more ways to seek to know them, yet sense-making seems ever more difficult.

In response, PPI SyEN is stretching, growing, and adapting to bring even greater value to you, our readers.

- We're putting together a larger, more diverse team of individuals to research and to produce content.
- We're reaching out to a broader group of leaders, thinkers, and practitioners in systems engineering and related areas.
- We're including even more value-added content that helps you to understand the "how" and "why" in addition to the "what".
- We're reaffirming our commitment to provide you with the best theoretical underpinnings and the best practices.
- We're freshening the design and format of presentation, to make it easier to choose what content to read, in what order.

Celebrating with friends: None of what we do matters, unless it matters to you, our readers. We're inviting you not only to celebrate our 100th edition with us, but also to be an active participant in making PPI SyEN ever better. We want to hear from you: what's working well, and what could be better, how.

So, step inside, have a look around, and let us know what you think about what we've done with the place.

Kevin

Kevin Nortrup
Editor, PPI SyEN

PPI Systems Engineering Newsjournal (PPI SyEN) seeks:	**PPI defines systems engineering as:**
➢ To advance the practice and perceived value of systems engineering across a broad range of activities, responsibilities, and job-descriptions ➢ To influence the field of systems engineering from an independent perspective ➢ To provide information, tools, techniques, and other value to a wide spectrum of practitioners, from the experienced, to the newcomer, to the curious ➢ To emphasize that systems engineering exists within the context of (and should be contributory toward) larger social/enterprise systems, not just an end within itself ➢ To give back to the Systems Engineering community	*an approach to the engineering of systems, based on systems thinking, that aims to transform a need into a description of a valid, holistic, verified, and life-cycle oriented solution that meets specialized requirements and that maximizes effectiveness in the eyes of the primary stakeholders whose interests are to be served by the system solution*

PPI SyEN FORUM

Selected correspondence from SyEN readers, authors, and editors

PPI SyEN FORUM offers the opportunity for feedback and discussion on topics around Systems Engineering – especially those that have been (or should be) addressed in PPI SyEN.
Please send your email to PPISyEN@PPI-Int.com

René King
Managing Editor, PPI SyEN

Welcome to the 100th Edition of the PPI Systems Engineering Newsjournal!

Since starting my role as Managing Editor of PPI SyEN in 2018, I have had the pleasure of reviewing numerous articles, written by authors from all corners of the globe and from a myriad of industries. Some articles assessed the effectiveness and challenges of applying systems engineering in aerospace and defense in a transforming world; others have highlighted the power of applying systems engineering to address challenges in social systems and in change-management, with coverage of practically everything in between.

Since the inception of PPI SyEN in 2008, its articles have explored the application of systems engineering to systems at all levels: from the enterprise system, the organization governing the social and technical components that come together to provide value through a product or service; to the technical software or hardware components that arise through sophisticated engineering and that are subject to rigorous verification and validation. Over the years, I have read thought-provoking articles about leadership and management in engineering, and on using the lens of systems engineering to solve problems and create a better life for humanity.

Then came 2020. Last year was a year that I'm sure none of us will forget – we each persevered through professional and personal challenges, perhaps many of which we never expected to encounter. As a result of the COVID-19 pandemic, thousands of businesses shut down – but just as many thousands have been transformed, and thousands of others have prospered. I am willing to bet that, of those companies that have managed to evolve and expand despite these unprecedented circumstances, they all benefited from the ability to think in systems – to see the interconnections between elements, to understand the interaction of humans and technology, and to look to the future and make decisions in the face of uncertainty.

We have seen the importance of cultivating a timely yet well-thought-out response in exceptional circumstances, and the value of sound data in equipping those responses. We have seen that thinking in silos, thinking about the "now" and not the future, thinking about "us" and not "them" will no longer work as our *modus operandi*. Indeed, that way of thinking in large part resulted in the drastic impact of the coronavirus; conversely, the ability to think in terms of systems has enabled the path to the new normal and to a more resilient global community. It's not a question of "why" or "when" anymore; it's a question of "how".

PPI SyEN exists to provide real insight into how people are using the principles, tools, methodologies, and approaches that fall under the umbrella of systems engineering; to inspire and to catalyze the progression of systems engineering from the perception as a small sector within the engineering field to the only way to go about engineering; and finally, to the new literacy for every human being. There was

a time when having the ability to read and write was a luxury – and then, it became a necessity. There will be a time when the ability to think in terms of systems – to perceive systems life cycles, interactions, and emergent properties – will be a necessity. One could argue that the point has already come.

I am interested to observe how PPI SyEN will contribute to the body of knowledge that will pave the way for getting from where we are now to where we want to be. That is a place where healthcare, education, infrastructure, and social systems serve to provide more equality, safety, and freedom for humanity. We are on our way: so much has been done, and there is so much yet to do. I look forward to the next 100 editions of PPI SyEN, as we witness the world of systems engineering evolve through the lens of this journal.

René

FEEDBACK

Don't make PPI SyEN run "open-loop"! Help us help you, by letting us know what's on your mind.

Do you have questions, comments, affirmation, or push-back for authors and articles in SyEN?

Are there trends in systems engineering that give you cause for celebration – or for concern?

What subjects, themes, or other content would be of greatest interest to you in future editions?

Would you be interested in suggesting a contributor – perhaps yourself – for a future article?

Tell us about it, at PPISyEN@PPI-Int.com

Keep it civil, sensible, and succinct – and your feedback just might appear in PPI SyEN FORUM.

We reserve the right to edit for clarity and content. All submitted ideas become the property of PPI. Void where prohibited. Your mileage may vary. Exclusions apply. Fine print rules!

"

"It must be remembered that there is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage, than the creation of a new system. For the initiator has the enmity of all who would profit by the preservation of the old institutions, and merely lukewarm defenders in those who would gain by the new ones."

Niccolo Machiavelli
"The Prince", 1532

SYSTEMS ENGINEERING NEWS

Recent events and updates in the field of Systems Engineering

Model Portfolio Management Guide - INCOSE Adoption?

A trusted collection of system models is increasingly essential to the development of complex systems and successful products. During the INCOSE International Workshop (IW2021), the Tool Integration & Model Lifecycle Management (TIMLM) working group hosted an informative session on the development of a proposed Model Portfolio Management Guide (MPMG).

The MPMG is intended to address several challenges:

- No current guide or standard addresses how to manage a collection of models
- Organizations score poorly on Model Management capabilities as assessed by the INCOSE Model-Based Capabilities Matrix (MBCM)
- The SERC SE Survey cited Model Management as an opportunity for improvement
- Acquisition organizations routinely ask for bidders to communicate their Model Management capabilities

In response to these challenges, Al Hoheb, Alexander Chang, Jordan Howie, and Misak Zetilyan of the Aerospace Corporation wrote and publicly released a Model Portfolio Management Guide (MPMG) to serve organizations who would like to improve their Model Management effectiveness. This corporate guideline, written following the INCOSE style guide, is being proposed as the foundation of an official INCOSE guide.

A draft plan has also been created to jump-start the transition from the interim solution to the official adoption and release of a MPM Guide by INCOSE. The Technical Product Plan has been finalized and is currently in the final acceptance review.

Look for future articles as the MPMG progresses.

The INCOSE Model-Based Capabilities Matrix Guide was the predecessor to the Model Portfolio Management Guide. The Matrix is available here and in the INCOSE Store.

INCOSE members may find more information on the TIMLM Working Group and the MPM Guide through INCOSE Connect or by contacting the TIMLM working group chair, John Nallon: jfnallon@outlook.com

INCOSE Sector Updates – EMEA

INCOSE chapters in the Europe, Middle East, and Africa (EMEA) sector report an active quarter that included the following milestones in 2020 and plans for 2021:

- A new INCOSE Belgium chapter was chartered in December, 2020 to better serve the engineering community and industries of Belgium, address a shortage of engineers trained in systems engineering disciplines and potentially increase INCOSE's ties with the European Union's decision-making institutions.
- The INCOSE-NL (Netherlands) chapter partnered in a Systems Architecting Conference in September. Sixty participants shared their daily challenges of applying systems architecting or systems engineering practices in real-life systems, products, or projects. INCOSE-NL looks forward to continuing this partnership, with four virtual conferences planned for 2021.

- The INCOSE-UK (United Kingdom) chapter has scheduled its Annual Systems Engineering Conference (ASEC 2021) for 16-17 November with a theme, "Creating Stability in Uncertain Times". See the conference site for the ASEC 2021 Call for Content.
- INCOSE-UK also announced a new release of *Don't Panic! - The Absolute Beginner's Guide To Architecture and Architecting* by Mike Wilkinson and Tim Rabbets. Copies may be pre-ordered at the UK INCOSE online store.

AI4SE WORKSHOP REPORT RELEASED

Systems Engineering (SE) is undergoing a digital transformation that will lead to further transformational advances in the use of Artificial Intelligence (AI) and Machine Learning (ML) technology to automate many routine engineering tasks. At the same time, applying AI, ML, and autonomy to complex and critical systems encourages new systems engineering methods, processes, and tools.

On October 28-29, 2020, the Systems Engineering Research Center (SERC) and the US Army Combat Capabilities Development Command Armaments Center (CCDC AC) Systems Engineering Directorate (SED) jointly sponsored the inaugural Artificial Intelligence for Systems Engineering/Systems Engineering for Artificial Intelligence (AI4SE/SE4AI) workshop. Attendees from Government, Academic, and Industry communities discussed how to define relevant SE and AI challenges, what areas of exploration and methodologies to use, and which ways in which to collaborate and research in the upcoming years.

More Information

SERC Sponsoring Survey on Impact of COVID-19 upon Systems Engineering

The Systems Engineering Research Center (SERC) invites professionals in the field of systems engineering to complete a survey on the impact that COVID-19 has had and continues to have on the broader systems-engineering community.

Data from the survey (10-15 minutes long) will be stored by Survey Monkey and SERC. The final anonymized dataset (with no individually or organizationally identifying information) will be retained by the SERC. Conclusions drawn from the results of the survey will be submitted for publication.

COMPLETION DEADLINE: Friday, 5 May 2021

More Information

ISO/IEC/IEEE 16085 Standard Updated

ISO/IEC/IEEE 16085 [*Systems and software engineering – Life cycle processes – Risk management*] provides a universally applicable standard for practitioners responsible for managing risks associated with systems and software over their life cycle. It has recently been revised to align with updates of other related standards, as well as to include new content related to risk management challenges inherent to large complex systems engineering programs and projects.

The new standard provides information on how to design, develop, implement, and continually improve risk management in a systems and software engineering project throughout its life cycle. It elaborates on the risk-management process described in International Standards ISO/IEC/IEEE 15288 [*Systems and software engineering – System life cycle processes*] and ISO/IEC/IEEE 12207 [*Systems and software engineering – Software life cycle processes*].

By providing a comprehensive reference for integrating the wide variety of processes, practices, techniques, and tools encountered in systems and software engineering projects and other life-cycle activities, ISO/IEC/IEEE 16085

enables a unified approach to risk management.

ISO/IEC/IEEE 16085 was developed by the joint ISO and IEC (International Electrotechnical Commission) technical committee ISO/IEC JTC 1, Information technology, subcommittee SC 7, Software and systems engineering, the secretariat of which is held by BIS, ISO's member for India. The standard was prepared in cooperation with the Institute of Electrical and Electronics Engineers (IEEE).

More Information

NIST's 4th Smart Grid Framework Details Future Interoperability Needs & Potential

Few engineered systems match the scale, complexity, and societal impact of the electric power grid. To address the impact of rapidly changing technologies, the U.S. National Institute of Standards (NIST) published in February 2021 the Framework and Roadmap for Smart Grid Interoperability Standards, Release 4.0.

The standard highlights the ability of improved interoperability to unlock the benefits of a modernized power system. The Framework examines the impacts of changing grid technologies in four areas:

- Grid operations
- Grid economics
- Grid cybersecurity
- Testing and Certification

The Framework promotes the use of two additional resources to address the ongoing evolution of cybersecurity challenges:

- NIST's Cybersecurity Risk Profile for the Smart Grid
- NIST's Guidelines for Smart Grid Cybersecurity

Billed as "required reading" for utility grid architects and cyber professionals, the Framework could be a source of useful patterns (interoperability, ontologies, operations, cybersecurity, economics, and testing/certification) applicable to other complex systems that are undergoing rapid technology-driven evolution.

Download the NIST Framework here.

SAE International Is Seeking Manuscripts

SAE non-event technical papers (formerly known as written-only papers) provide authors the opportunity to publish their original work outside of a specific event's production timeline. These papers are made available on SAE MOBILUS®, SAE's robust online digital library platform, on an accelerated pace after a blinded peer-review process and are indexed in Scopus and Engineering Village (Ei Compendex).

SAE International, previously known as the Society of Automotive Engineers, is a U.S.-based, globally active professional association and standards developing organization for engineering professionals in global transport industries such as aerospace, automotive, and commercial vehicles. Its standards include EIA-IS-632, "Systems Engineering"; EIA-731-1A, "Systems Engineering Capability Model"; and EIA-IS-731-2, "Systems Engineering Capability Model Appraisal Method".

More Information

IEEE Offering 50% New Membership Discount

The Institute of Electrical and Electronics Engineers (IEEE) is the world's largest technical professional organization for the advancement of technology. IEEE and its members inspire a global community to innovate for a better tomorrow through its more than 420,000 members in over 160 countries.

With its highly cited publications, conferences, technology standards, and professional and educational activities, IEEE is the trusted "voice"

for engineering, computing, and technology information around the globe. IEEE membership offers access to technical innovation, cutting-edge information, networking opportunities, and exclusive member benefits. Members support IEEE's mission to advance technology for humanity and the profession, while memberships build a platform to introduce careers in technology to students around the world.

IEEE sponsors: a Special Technical Community on Systems Engineering (STC-SysE), whose mission is to advance the principles and practices of systems engineering as applied to development and sustainment of computer-based and software-intensive systems; an International Symposium on Systems Engineering (IEEE ISSE), providing an interactive forum for the advancement of the practice of systems engineering across the multiple disciplines and specialty areas associated with the engineering of complex systems; and the Body of Knowledge and Curriculum to Advance Systems Engineering Project (BKCASE).

New members can join now and get membership benefits through the end of 2021 while saving 50% on membership dues.

More Information

PROJECT PERFORMANCE INTERNATIONAL

PPI Revs Up for the Systems Engineering Tools Database (SETDB) Release

After 3 years of sustained collaboration and effort between PPI and INCOSE, SETDB is maturing into a fully-fledged website to find the right tool to suit your systems engineering need. The INCOSE IW2021 saw the release of SETDB V0.9, which enabled tool vendors to sign up and load information about their tools – a major milestone. At INCOSE IS2021, a follow-up version of the SETDB is to be released, featuring some capability surveys and enhanced system functionality. We can't wait to share with the world what we have been working on in the last few months.

Visit the SETDB V0.9

Terry Fitzgerald joins the CTI team

It is with great joy that CTI welcomes Terry Fitzgerald to its team of presenters. Terry is an esteemed engineer and modeling expert with a host of qualifications and certifications, including CSEP, PMP and advanced systems modeling attributions. Terry is the latest addition to our strong team of experienced engineers and course facilitators. We are excited about the expansion of our team and look forward to Terry's contribution in fostering more certified systems engineering practitioners throughout the world.

DEFINITION

Artificial Intelligence (AI): A branch of computer science, devoted to developing data-processing systems that perform functions normally associated with human intelligence, such as reasoning, learning, and self-improvement.

ISO/IEC 2382:2015 Information Technology

CONFERENCES, MEETINGS & WEBINARS

Upcoming events of relevance to Systems Engineering

WEBINAR: What PMI and INCOSE are doing to advance the Future of PM-SE Integration (INCOSE)

Wednesday, April 21, 2021 from 11:00am-12:00pm EDT (3:00pm-4:00pm UTC)

Speakers: Bernardo Tirado, Dave Garrett, Olivier Lazar, David Urias, Kerry Lunney, Marilee Wheaton, Mitchell Kerman, Tina Srivastava, and PPI's Randall Iliff

Information and Registration

MEETING & PROGRAM: Experiments in Leading through Influence: Reflections from a Group of Emerging Technical Leaders (INCOSE-CC)

Wednesday, April 21, 2021 (6:00 – 8:00 pm EDT)

Speakers: David Fadeley, ESEP; and Myra Parsons-Gross, ESEP

Information and Registration

CALL FOR PROPOSALS: Western States Regional Conference (INCOSE)

Event: September 17-19, 2021 (San Diego)

Submission deadline: April 25, 2021

Information and Submission

WEBINAR: The Convergence of and the Emerging Necessity of both Model-Based Engineering and Model-Based Systems Engineering

April 27, 2021 | 1:00 - 2:00 PM EDT

Dr. J. Robert Wirthlin, Senior Technical Leader, Systems Engineering, Ford Motor Company

Information and Registration

WEBINAR: How Can a Systems Approach Help Critical Civil Infrastructure Become Smarter, More Sustainable and Resilient?

April 28, 2021 | 1:00 PM EDT

Speaker: Michael Salvato, Vice President, Infrastructure Advisory Practices, Mott MacDonald

Information and Registration

ISACA® Conference North America

May 4-6, 2021 (Virtual)

Includes CMMI Capability Counts conference

Keynote speakers: Sebastian Terry, Leroy Chiao, Michelle Poler

Registration closes Friday, April 30 @ 5pm EDT (GMT -5). Use Promo Code NAC21LC and save US$150 (Full Conference only)

Information and Registration

WEBINAR: There Is No (Real) Systems Engineering Without Systems Thinking (INCOSE-CC)

Wednesday, May 19, 2021 (6:00 – 8:30 pm EDT)

Speaker: Zane Scott

Information and Registration

Institute of Industrial and Systems Engineers (IISE) Annual Conference

May 22-25, 2021 (Virtual)

Keynote speakers: Nadine Sarter, Andres Medaglia, Walt Ehmer

Early-bird registration closes May 3, 2021

Information and Registration

CONFERENCES, MEETINGS & WEBINARS

SEE YOU THERE!

Project Performance International (PPI) will be an exhibitor at the 31st Annual INCOSE International Symposium (IS-2021), a virtual event on July 17-22, 2021.

Upcoming scheduled training via PPI Live-Online™

For more information on content, costs, and delivery, please visit the PPI Live-Online™ website.

Course Title	Targeted Region	Local Starting Time	Dates
Systems Engineering	North America	8:00 EDT (UTC -4:00)	April 26-30, 2021
Systems Engineering	South America *[only]*	9:00 BRT (UTC -3:00)	April 26-30, 2021
Systems Engineering	Asia	6:00 SGT (UTC +8:00)	April 26-30, 2021
Systems Engineering	Oceania	8:00 AEST (UTC +10:00)	April 26-30, 2021
Systems Engineering Management	North America	8:00 EDT (UTC -4:00)	May 3-7, 2021
Systems Engineering Management	South America *[only]*	9:00 BRT (UTC -3:00)	May 3-7, 2021
Systems Engineering	Europe	9:00 CEST (UTC +2:00)	May 10-14, 2021
Systems Engineering	United Kingdom	8:00 BST (UTC +1:00)	May 10-14, 2021
Systems Engineering	South Africa *[only]*	9:00 SAST (UTC +2:00)	May 10-14, 2021
Systems Engineering	Turkey	8:00 TRT (UTC +3:00)	May 17-21, 2021
Systems Engineering	Saudi Arabia	8:00 AST (UTC +2:00)	May 17-21, 2021
Requirements, OCD & CONOPS in Military Capability Development	Europe	9:00 CEST (UTC +2:00)	May 17-21, 2021
Requirements, OCD & CONOPS in Military Capability Development	United Kingdom	8:00 BST (UTC +1:00)	May 17-21, 2021
Requirements, OCD & CONOPS in Military Capability Development	South Africa *[only]*	9:00 SAST (UTC +2:00)	May 17-21, 2021

PPI offers public and in-house training, virtually and (when travel restrictions permit) in-person. Access the full list of our course offerings here: https://www.ppi-int.com/training/.

PPI also offers a range of consulting and bespoke systems-engineering services to help your projects succeed. To find out more, visit our website: https://www.ppi-int.com/consulting/.

Reliability is Too Important to Consider Separately

The critical role of reliability motivates the need for improved system-reliability models in the early design stages.

By Tevari Barker, Dr. Gregory S. Parnell, Dr. Edward A. Pohl, and Dr. Randy K. Buchanan

Abstract: Traditional reliability approaches often require detailed knowledge of a system and are used in later design stages as well as development and operational test and evaluation. The critical role of reliability and its impact on acquisition program performance, cost, and schedule motivate the need for improved system-reliability models in the early design stages. Reliability is often a stand-alone requirement. The U.S. Army Engineer Research and Development Center seeks to integrate reliability, performance, and cost models in a trade-off analysis framework in the early acquisition stages. The Center is developing models that estimate reliability Pre-Milestone-A to assess the impact of reliability on performance and cost models of early system concepts. Our research focuses on the development of models to estimate the system reliability of Unmanned Ground Vehicles (UGV), using knowledge and data from similar systems. We propose three approaches for estimating reliability based on the type of system to be developed: 1) all-new system design, 2) a system with a mix of existing and new subsystems, and 3) systems integrating.

Introduction

The United States Department of Defense (DoD) needs to incorporate reliability information before Milestone A because it significantly impacts program performance, cost, and schedule estimates [1]. We are investigating new approaches that assess performance, cost, and schedule in an integrated framework of models for early life cycle prediction of reliability Pre-Milestone A. The intent is to perform trade-off analysis by identifying design decisions for Unmanned Ground Vehicles (UGVs). A tradespace will be generated using design decisions to assess the feasibility, performance, and cost of design concepts – with and without the early system design's reliability model. The resultant tradespace will allow us to describe the value-added by early reliability assessment.

We selected UGVs for our research due to data availability and the significant interest in potential system developments for military and civilian applications. Typically, we have limited design information early in system concept development. One of the challenges for an integrated framework of UGV models is developing the appropriate parametric models. Understanding the relationships between concept technology decisions and performance provides a path to trade-off analysis. Advancements in UGV technology within military applications are ongoing, and our research can provide insights for decision-makers on the impact of reliability in early UGV design stages.

An Integrated Model Incorporating Reliability

The integrated reliability model incorporates reliability in system design feasibility and evaluation of design concepts using trade-off analysis. Reliability is included in performance measures using the mission chain and into the Life Cycle Cost model using projected operational usage and the impact of reliability on life cycle cost elements [2].

Influence Diagram for Integrated Models

An influence diagram was developed (Figure 1) [3] to capture the relationships between stakeholder needs, requirements, system alternatives, technology/manufacturing, integration readiness, stakeholder objectives, models, and simulations used for reliability and system performance modeling the integrated trade-off analysis. The example begins with stakeholder needs, with the assumption that most of the needs are known. Stakeholder needs turn into system requirements to meet those needs. Requirements lead to objectives, models, and simulations mapping to performance measures.

Objectives of those performance measures include maximizing UGV transportability, maximizing survivability in operational environments, maximizing the probability of enemy detection, maximizing all-weather capability, and minimizing personnel risk. Performance measures in our UGV model include total vehicle weight, mission range, probability of being detected, and the ability to operate in extreme temperatures. An additional measure that is not a physical measure of the UGV is the number of personnel deployed in the theater of operations.

Our team uses the objectives, models, and design alternatives to assess the performance, cost, and time to develop the desired UGV system. The value, cost, and schedule of potential concept designs are assessed and compared using integrated trade-off analysis.

Assessment Flow Diagram for Integrated Models

An Assessment Flow Diagram (AFD) [4] was developed to describe the flow of information and the models needed to calculate performance measures and life cycle cost. As shown in Figure 2, an AFD for a UGV surveillance vehicle was developed. The AFD

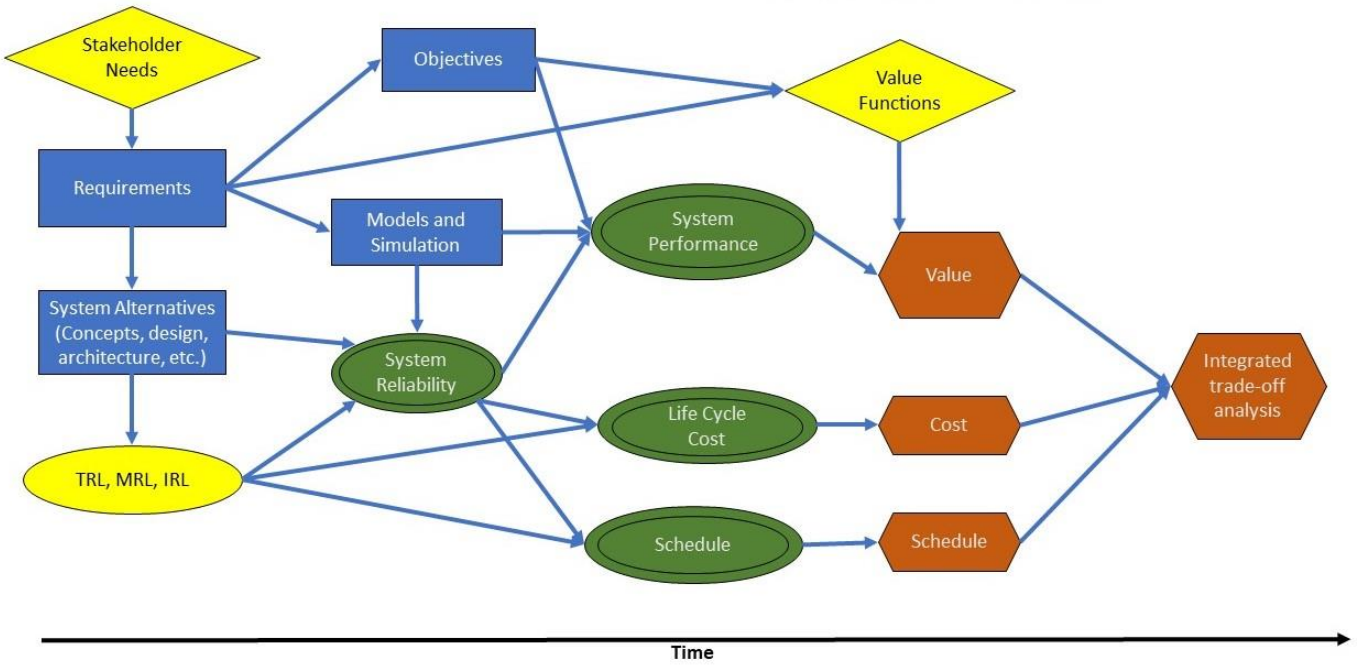

Figure 1. UGV Influence Diagram for Integrated Models

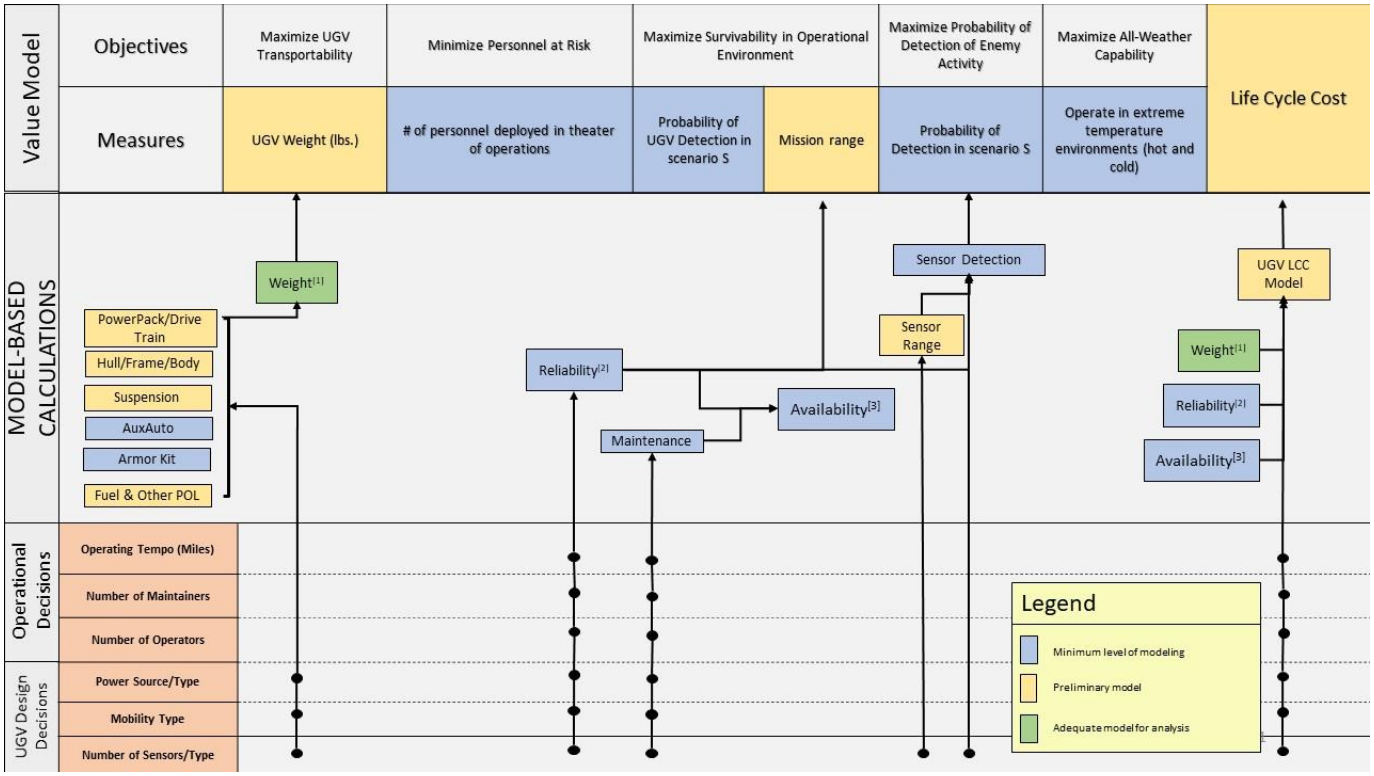

Figure 2. UGV Assessment Flow Diagram for Integrated Models

starts with design decisions such as mobility type, power source types, and various sensor technology platforms. Design and operational decisions are inputs to the performance modules shown in the model-based calculations section, inevitably impacting the design concept's performance measures and life cycle cost. The color-coding in the figure aids in describing the current modeling progress.

The current research focus is for developing models for UGV weight, reliability, availability, mission range, and detection probability of enemy activity. The effects of design decisions on reliability and the impact of reliability on performance and cost are of major interest. We plan to expand our integrated models to add additional performance measures and improved reliability models.

The Type of System Development Drives Reliability Methods

As noted above, we have defined three types of systems developments: 1) all-new system design, 2) a system with a mix of existing and new subsystems, and 3) systems integrating existing subsystems. A research question was: "Is the way that we model system reliability based on the maturity of technologies used in subsystems"? Therefore, reliability for the various types and stages of system development was considered during the reliability model development.

An ongoing literature review is focused on early reliability prediction for conceptual design and early life cycle stages. An approach we found intriguing was the early design reliability prediction method (EDRPM) that calculates function and component failure rate distributions [5]. In this technique, failure rates can be extended to reliability values. A new approach called Frequency Weighting was developed and used with Hierarchical Bayesian models, which account for the number of times a component has performed a function previously. We will take a similar approach to define a method of using functional reliability block diagrams to estimate UGV system reliability in our integrated modeling framework.

Future Efforts

Next steps include developing and evaluating pre-milestone A reliability models. Initial results

support continued work on reliability modeling methods using the UGV system concept level trade-offs. Importantly, system-level trade-offs are the system concept decisions that impact performance, cost, and schedule. Design decisions will start broadly and increase in fidelity as the design matures. We plan to first generate the tradespace by enumerating all combinations of design decisions. As work progress, we plan to use quantitative Set-Based Design to perform trade-off analysis with a wide range of discrete and continuous design decisions [6].

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FEEDBACK: Do you have experience with (or opinions about) integrating reliability – and other "-ilities" – into requirements, models, and design throughout the system life cycle? Tell us: PPISyEN@PPI-Int.com

About the Authors

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Dr. Gregory S. Parnell is a Professor of Practice, Department of Industrial Engineering, University of Arkansas and is Director of the M.S. in Operations Management (largest graduate program at the university) and the M.S. in Engineering Management programs. His research focuses on systems engineering, decision analysis, and risk analysis. He is editor of Trade-off Analytics: Creating and Exploring the System Tradespace (2016), lead editor of Decision Making for Systems Engineering and Management, (2nd Ed, 2011), and lead author of the Handbook of Decision Analysis (2013). He is a fellow of the International Committee for Systems Engineering, the Institute for Operations Research/Management Science (INFORMS), and the Military Operations Research Society (MORS). He is a Past President of the INFORMS Decision Analysis Society and the MORS. He previously taught at West Point, the U.S. Air Force Academy, the Virginia Commonwealth University, and the Air Force Institute of Technology. He received the Frank P. Ramsey Medal from the Decision Analysis Society, in 2014, and the INFORMS Steinhardt Prize in 2020. He has a Ph.D. from Stanford University and is a retired Air Force Colonel.

Edward A. Pohl, PhD
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Edward A. Pohl is a Professor and Head of the Industrial Engineering Department and holder of the 21st Century Professorship at the University of Arkansas. He has participated and led reliability, risk, and supply chain related research efforts at the University of Arkansas. Before coming to Arkansas, Ed spent twenty-one years in the United States Air Force where he served in a variety of engineering, operations analysis, and academic positions during his career. Ed received his Ph.D. in Systems and Industrial Engineering from the University of Arizona. He holds a M.S. in Systems Engineering from the Air Force Institute of Technology, and M.S. in Reliability Engineering from the University of Arizona, an M.S. in Engineering Management from the University of Dayton, and a B.S. in Electrical Engineering from Boston University. Ed is the Co-Editor of the Journal of Engineering Management, on the Editorial Board of the IEEE Transaction on Technology and Engineering Management, Military Operations Research Journal, and Systems. Ed is an Associate Editor for IEEE Transactions on Reliability and the Journal of Risk and Reliability. Ed is a Fellow of Institute of Industrial and Systems Engineering, a Fellow of the Society of Reliability Engineers, a Fellow of the American Society of Engineering Management, a Senior Member of IEEE and ASQ, a member of INCOSE, INFORMS, ASEE, MORS, and AHRMM.

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Full Analytical Criteria Method (FACM)

FACM combines the Analytical Hierarchy Process (AHP) with other tools to generate alternatives and to identify selection criteria.

By Zane Scott

Introduction

The Full Analytical Criteria Method (FACM) is derived from the work of Dr. Thomas Saaty and others on the Analytical Hierarchy Process (AHP). The AHP uses a nine-point scale to evaluate several alternative solutions against each other with respect to a single criterion at a time. It accommodates multiple criteria by using the same scale to evaluate the relative importance of the criteria and assigning weights to those criteria based on the outcomes of the comparisons. The various alternatives can then be processed repetitively, one criterion at a time, and the results can be synthesized using the weights assigned to each criterion. The power of the AHP is in the use of one-to-one (head-to-head) comparisons.

The FACM streamlines the AHP process and makes it well suited for use by a group (e.g., an Integrated Process Team). This is done by using a five-point comparison scale and by combining the FACM with other creativity and decision tools to generate the alternatives and identify the selection criteria to be used. Tools, such as traditional brainstorming or brain writing, are used to generate ideas and are coupled with prioritizing techniques (e.g., Nominal Group Technique) to refine the results into a useable list of criteria or alternatives. The goal of the front-end process is to limit the alternatives and criteria to be analyzed to lists of five or fewer. This culling of alternatives, along with the use of the simpler five-point scale, makes FACM a useful and manageable decision process for almost any group.

Arguably, the primary value of the FACM lies not in the numbers and rankings generated by the process, but in the discussion of the criteria and alternatives as they are systematically contrasted with each other in the FACM. Such comparisons elicit exactly the right information and analysis for the group to use in thinking about the choices and the decision to be made.

Technique

Matrices: The FACM uses a series of matrices to organize and preserve the comparisons. The number of criteria that are selected for the process determines the number of matrices used. The first matrix is used to weight the criteria. Then, each criterion is used in a separate matrix to compare the alternatives to each other, based upon that criterion. Finally, the results of each criterion-evaluation comparison-matrix are compiled and weighted with the respective criterion weights that were established in the first matrix, and the results are synthesized into a final matrix. Therefore, there is always the number of criteria plus two matrices (one matrix per criterion, plus the criteria weighting matrix, plus the final synthesis) used in a FACM process.

Scale: FACM uses a five-point scale to compare criteria or alternatives. The scale of the relative importance or performance (with weighting) is:

- Much More Important (10 points)
- More Important (5 points)
- Equally Important (1 point)
- Less Important (0.2 point)
- Much Less Important (0.1 point)

Process:

- The first step is to use a divergent-thinking tool to generate the possible criteria to be used in making the decision. Most of the time in a large group setting, this will be traditional brainstorming or a modified version of it. Smaller groups may want to explore tools such as brain writing to generate the list. The list of possible criteria generated are then subjected to evaluation, using a convergent group tool such as Nominal Group Technique (NGT), with the goal of trimming the list to five or fewer criteria to be used in the FACM analysis.
- Next, a divergent-thinking tool is used to generate a list of alternative solutions to be evaluated. This list is trimmed in the same way to five or fewer alternatives for the final analysis.
- With the two final lists in hand, the group is ready to begin the actual FACM process. The first matrix is the criteria-weighting matrix.

As we see in Figure 1, the criteria are listed (in no particular order) across both axes of the matrix (down the left side and across the top). Note the diagonal with the boxes "X'ed" out: This is because no criterion is ever compared to itself. The analysis proceeds by comparing Criterion 1 to Criterion 2, then to 3 etc. It is important that the ROW is compared to the COLUMN consistently throughout. The numerical values are then systematically entered for all comparisons. Note that, for all the inverse comparisons, C1 to C2 and C2 to C1, the values in the two boxes are the reciprocals of each other.) This stands to reason because, if C1 is "more important" than C2 yielding a (5), then C2 is "less important" than C1 yielding a (.2) - the reciprocal of (5).

The values in each row are then totaled. The resulting Row Totals are added together producing a "Grand Total." By dividing each row total by the Grand Total, the Criteria can be weighted in a manner reflecting their relative value to the decision process (expressed as decimal values which sum to percentages).

Similarly, a series of matrices are constructed (one for each criterion) with the alternative solutions listed across the axes to set up the same head-to-head comparison process. Each of the matrices would look like Figure 2.

The comparisons proceed in the same way as in the Criteria weighting. This time, the statement to be completed is, "With respect to (the criterion involved in this matrix), the Row is _____ than the Column." That statement is completed by completed by choosing one of the options: "Much More Important", "Better More Important", "Of Equal Importance", etc.

	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Row Totals	Citeria Weights
Criterion 1	X					RT1	RT1/GT
Criterion 2		X				RT2	RT2/GT
Criterion 3			X			RT3	RT3/GT
Criterion 4				X		RT4	RT4/GT
Criterion 5					X	RT5	RT5/GT
Grand Total (GT= Σ RTs)						GT	

"The ROW is ____ to the decision than the COLUMN"

Much More Important = 10
More important = 5
Of Equal Importance = 1
Less Important = .2
Much Less Important = .1

Figure 1. Criteria Weighting

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Row Totals	Performance Score
Alternative 1	X					RT1	RT1/GT
Alternative 2		X				RT2	RT2/GT
Alternative 3			X			RT3	RT3/GT
Alternative 4				X		RT4	RT4/GT
Alternative 5					X	RT5	RT5/GT
Grand Total (GT= Σ RTs)						GT	

"With respect to (CRITERION) the ROW performs _____ the COLUMN"

Much Better Than= 10
Better Than = 5
Equally Well = 1
Worse Than = .2
Much Worse Than = .1

Figure 2. Comparison by (CRITERION)

Again, by completing the statement from the legend with a comparison, the corresponding numerical value can be entered in the intersection box in the matrix. As in the discussion of the Criteria Weighting, the principles of reciprocity and logical integrity (Better/Worse; 5/.2) apply here.

These discussions can, and should, be fueled with research. More than the comparisons of the "importance" of criteria to the decision, the performance of the alternatives with respect to the criterion being discussed may well be ascertainable. The discussion process will surface the need for information. Sometimes the process may even be halted or rerun, based on this need.

Once the comparisons are made to the group's satisfaction, the same process of getting Row Totals and coming up with percentage rankings applies here as it does in the Criteria Weighting. The numbers that are generated are the relative Performance scores of the various Alternatives.

One final matrix (figure 3) is used to draw the comparisons together.

In this matrix, the values derived in the other scorings are aggregated to derive a final comparison of the alternatives. The Performance Scores (PS) from the Comparison by Criterion matrices are entered for each alternative. Then, the Criterion Weights (W) are

	C1			C2			C3			C4			C5			
	PS	W	S	PS	W	S	PS	W	S	PS	W	S	PS	W	S	FINAL
ALT 1																
ALT 2																
ALT 3																
ALT4																
ALT 5																

Figure 3. Final Scoring

listed for each criterion (the same value is entered in each row of the "W" column for a particular criterion). The Score (S) is computed by multiplying the performance score by the criterion weight [PSxW=S]. The scores are then summed for each alternative (row) to get a final score [Σ S(C1 . . . C5) = FINAL]. The alternatives can now be ranked in order of their performance under the weighted criteria, by ordering them from high score to low score.

Notes: The final scoring matrix embodies the rationale of the group. It reveals where alternatives rose and fell. (e.g., Statements like, "Alternative 1 did well on Criterion 3 – far surpassing the others. However, Criterion 3 was given very little weight, so what appeared up front to be a sizeable advantage turned out not to carry much weight in the final analysis.") Some participants have commented that the process and the matrices "write the report for you", meaning that it is relatively easy to trace the scoring back to specific comparisons and, especially with good discussion notes, recall the rationale that led to critical elements of the final outcome.

It is equally important to note that the "final score" is not binding. The focus is on the discussion. When that discussion reveals that the process is flawed in some way (such as, there are other criteria not being considered in the formal analysis etc.), it becomes perfectly acceptable to choose a different alternative (perhaps the "second" choice) or even to rerun the whole process altogether. The major value of this tool is that it surfaces the right issues and airs them among the decision makers.

Hints and Tips:

It is the discussion of the comparisons (e.g., "Is the Row better than the Column or is it much better? Why?") That is the real "goody" in this process: it is in those discussions that the decision crystallizes.

If the spreadsheets are automated using a spreadsheet program, the related comparisons can easily be set up to automatically enter the reciprocal values, thereby automatically preserving the logical integrity of the comparisons.

An automated spreadsheet can be set up to import the values for Performance Scores and Criteria Weights into the final matrix. Then, using formulae, the Scores can be calculated and summed automatically, producing the completed sheet without additional time or effort.

The group needs to see the comparison values as they make them. They may or may not do this by seeing the actual matrix as it is filled in. Various facilitation processes can be used to complete the matrices. These can include projecting the actual spreadsheet matrices one at a time and filling the comparison values into them as they are elicited from the group discussion. The optimal solution depends upon the facilitator of the discussion, who must elicit comments and analysis from the group while freed from the necessity of entering the data. This is easily done by separating the data-entry role from the facilitator duties and by facilitating in a team of two: one leading the discussion and the other running the spreadsheet. The goal of the process is to promote a rich discussion and to allow the group to see what they are doing as they do it.

FACM and Systems Engineering

The FACM is ideally suited to a systems-engineering "down-select" of alternatives. The use of numbers and quantification of decisions adds a measure of comfort for technical professionals. At the same time, the discussion of the criteria for the down-selection, along with the alternative comparisons criterion-by-criterion, creates the real value from the FACM. Instead of the multiple cross comparisons, the head-to-head analysis cuts through the complexity, leading to a readily understandable rationale that is transparent to all participants.

The FACM encourages weigh-in by all participants, regardless of their respective points of view or level of understanding.

FEEDBACK: Do you have experience with (or opinions about) the Full Analytical Criteria Method, the Analytical Hierarchy Process, or similar methods and tools? Let us know: PPISyEN@PPI-Int.com

About the Author

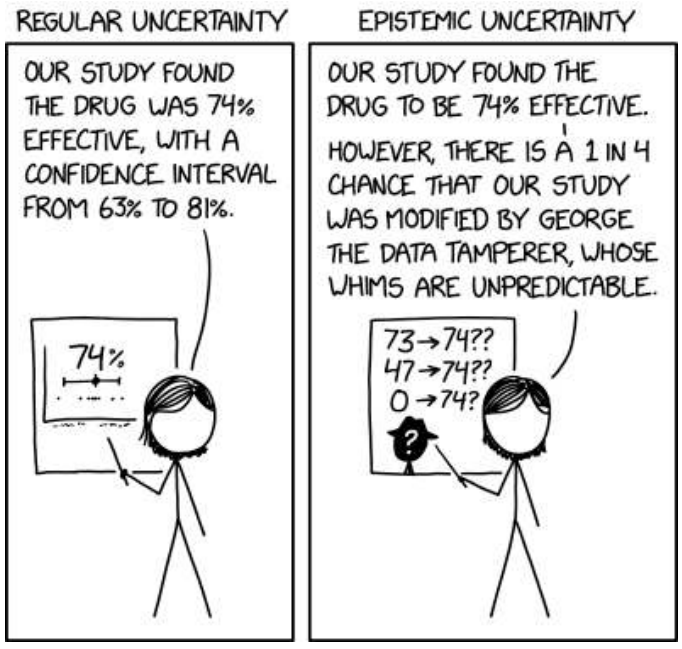
Zane Scott

Over the course of nearly 40 years, Zane has built his professional skills and expertise through a multi-faceted career. As the Vice President for Professional Services at Vitech Corporation, he is responsible for leading the delivery of training and consulting services as well as the development of educational and intellectual collateral. A frequent blogger and speaker on systems-engineering topics, Zane co-authored Vitech's Primer for Model Based Systems Engineering with David Long, Vitech's President.

Active in the International Council on Systems Engineering (INCOSE), Zane has served as the Chair of the Corporate Advisory Board and a member of the Board of Directors. He has delivered the "SE 101" tutorial for the INCOSE International Symposium for three years (2013-2015), won a Best Paper Award (with Dave Walden of Sysnovation) at IS 2016, and teaches the fundamentals of systems engineering for Vitech with other companies and INCOSE Chapters.

Zane comes to the world of systems engineering with a diverse and interesting background, having been a trial attorney, hostage/crisis negotiator, labor management facilitator, and mediator. He is a member of the inaugural cohort of INCOSE's Institute for Technical Leadership and is particularly interested in developing leadership skills among engineers and other technical professionals. Before joining Vitech, Zane worked as a senior consultant and process analyst, assisting government and industry clients in implementing and managing organizational change.

XKCD: Epistemic Uncertainty



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"A systems-engineering process-standard is not a substitute for engineering competence, common sense, and hard work."

Robert John Halligan

Modeling the Mission Dimension of an Intravascular Medical Device

Applying MBSE methodology ISE&PPOOA to model the mission dimension of a micrometric-size robotic joint for minimally invasive surgical techniques.

By José L. Fernández, Juan A. Martínez, and Efrén Díez-Jiménez

At the Systems-Engineering Transformation and Model-Based Systems Engineering (MBSE) Initiative of the INCOSE International Workshop IW-2021, the authors presented the application of the MBSE methodology, ISE&PPOOA (Integrated Systems Engineering & Pipelines of Processes in Object Oriented Architectures) to model the mission dimension of an intravascular medical device. This research aims to develop a micrometric-size robotic joint, enabling the creation of micro-robotic complex mechanisms for minimally invasive micro-surgery techniques and *in-vivo* health treatments. The robotic joint will contain a micro-motor connected to a new type of long-lasting gearbox. One critical issue is that the robotic joint (motor + gear) will be wirelessly powered, thus providing long endurance to any tool or micro-robot activated by it. Other approaches for micro energy harvesting can be found in the literature (Brand, 2015).

The scope of application of the mission dimension in the methodology ISE&PPOOA is less ambitious that some other mission-engineering approaches. For example, the US DoD Mission engineering and Integration Guidebook (DoD, 2019) defines a ten-step process to identify the systems-of-systems mission and its success factors, mapping the mission-success conditions and systems to the mission tasks. However, we apply the ISE&PPOOA methodology process as the

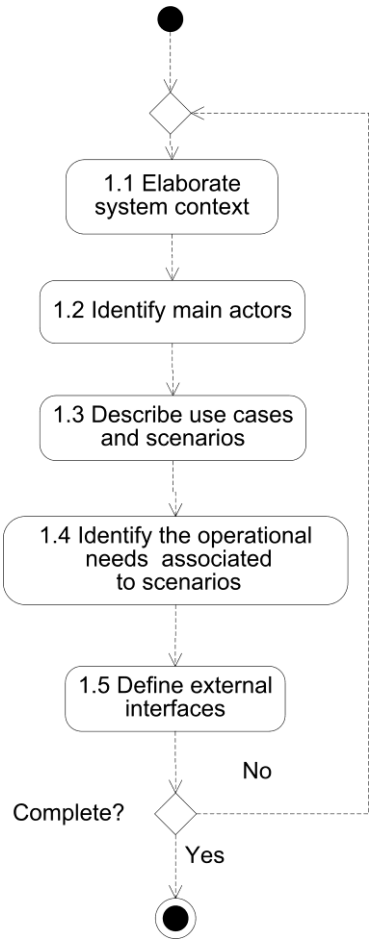

Figure 1. ISE&PPOOA Mission Subprocess

assembly of three dimensions: Mission, System and Software (Fernandez, 2019).

The mission-dimension scope, as defined by ISE&PPOOA and shown in Figure 1, has as its main outcomes: the model of the system context; the identification of the main interactions between the system and external entities, including other systems, devices, people or environment; the description of the

operational needs associated with these interactions (use cases and scenarios); and the definition of the main external interfaces.

The main view and SysML standard notation used for the representation of the mission-dimension model are an internal block diagram for representing the system logical context, where the system and the external entities interacting with it are represented as blocks. Another important diagram is a use-case diagram, representing the interactions as use-cases. It is important to keep safety and security issues in mind – "sunny day" is not the only situation – and so misuse cases are identified as well. The scenarios or execution paths of each use case can be described textually or using SysML activity diagrams.

Operational needs, as recommended in the INCOSE Requirements Engineering Guide (INCOSE, 2017), are the expectations as stated in the language of stakeholders at the operations level. Requirements are generated from needs through a process of requirements-analysis. Here, operational needs are described textually, with the corresponding external entities identified along with their respective needs.

External interfaces are described textually. An external-interface definition consists of one or more statements about the characteristics of each external entity at the interface, the characteristics of what crossed the interface, or the media involved in the interaction (Vipavetz, 2016) (Davies, 2020). Before defining the external interfaces, we identified them by modeling as an internal block diagram in SysML notation the system logical context, presented in Figure 2.

To conclude, we emphasize that a good model of the mission dimension is critical for an "out-in" modeling of a customer-oriented system. Technology is an important issue, but in domains such as medical applications, the users and the patients are more important, so out-in approaches to the system modeling are the best option.

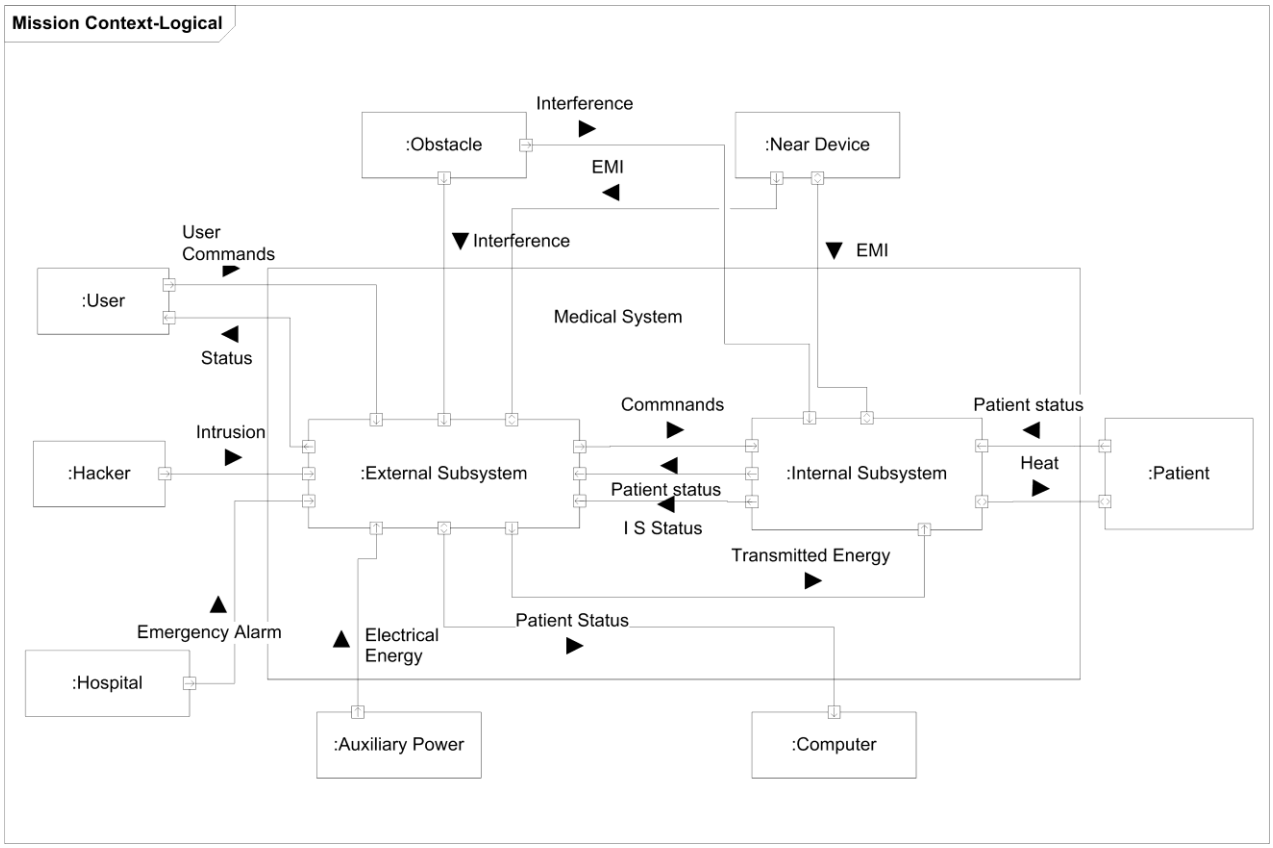

Figure 2.Contextual view of the intravascular medical device

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PPI SyEN SPOTLIGHT: EDUCATION

Interview with Dr. Alan Ravitz, program chair for the Healthcare Systems Engineering Master's Degree track through Johns Hopkins University's "Engineering for Professionals" Program

Kevin Nortrup, Editor of PPI SyEN, sat down with Dr. Ravitz to learn the backstory and objectives of this relatively new program. The following excerpts from that interview are edited for clarity and for conciseness.

What prompted the creation of the Healthcare Systems Engineering Master's Degree program?

The field of healthcare has made incredible advancements, yet there remain significant gaps that include safety, quality, value (as a function of outcomes versus costs), access, and missed opportunities to disseminate solutions and knowledge. The IOM (Institute of Medicine, now National Academy of Medicine), the Royal Academy of Engineering, and others have noted that the field has not fully capitalized upon the tools and best practices that are associated with systems engineering.

Furthermore, it's important that we have more people who can understand complex, adaptive systems and who can apply that understanding in the field of healthcare. There's perhaps no better example of the complexity of people, process, policy, and technology coming together than that in health and healthcare.

Our goal is to equip technical professionals and health professionals with knowledge of these tools and best practices, so that they can change the field from within.

Historically, there hasn't been much perceived need or demand for such capabilities in healthcare, because those in the field didn't really know that such capabilities even existed. Therefore, another objective of the program is simply to make people better aware of the problems and challenges that Healthcare Systems Engineering could help to solve.

What are some examples of those problems and challenges?

First, let's recognize the remarkable progress that healthcare has made over the years: we live longer, happier, healthier lives because of the application of science and technology in healthcare.

However, such application often is not as effective or as efficient as it should be. For example, when Electronic Medical Records (EMRs) were introduced, they were advertised to be a great enabler for better medicine. While there have been many advantages with EMRs, they came with a lot of struggles that still last until today; clinicians still spend too much time interacting with the technology instead of interacting with the patient.

Another example is that critical-care nurses can spend a large percentage of their time just looking for needed items, because workflow hasn't been optimized.

In both cases, there is opportunity to engineer the overall system more holistically than has been done in the past.

How does the program define "systems" and "systems engineering"?

The word, "system", can mean different things to different people. It can refer to multiple healthcare organizations working together as a whole – and there is a systemic element to that. But more largely, there's a set of challenges wherever people, process, and technology intersect and are interdependent as a system, at every level in the healthcare organization. There's also the upstream side of

healthcare: keeping people healthy before they need healthcare. Therefore, we can realize greater value if we understand and approach health and healthcare as a system of systems.

However, so much of healthcare has emerged from bottom-up, reductionist practices and mindsets that tend to ignore critical interdependencies. Repercussions from such unintentional emergence can affect all levels of the system, from sharing medical data among providers and payors, to interoperability of medical equipment across the hospital and even at the bedside. Systems engineering can help to transition from reductionism to holistic approaches that improve overall value.

Our Healthcare Systems Engineering program is derived from the Systems Engineering program offered by the Whiting School of Engineering's Engineering for Professionals (WSE EP) program. Their definition of systems engineering is the conceptualization of a desired end-state, the characterization of the current state, and then the methodical progression from current to future state.

What are the major components of the curriculum of the program?

The program includes five main core courses that progress through the system-development lifecycle, four elective courses to enrich the student's experience and to tailor their education to their interests, and finally a capstone project in which they focus on applying their knowledge of the best practices and tools of systems engineering to a specific challenge experienced in the field. Each core course includes a group project to emphasize the team-approach required to address complex challenges. Since our enrolled students are a mix of technical professionals and healthcare professionals (including administrators and clinicians), these groups benefit from diverse perspectives, which leads to creative thinking and enhanced learning opportunities.

How does the program equip its graduates to use systems engineering to drive positive change in healthcare?

Our program reinforces the notion of the need for a "systems approach" to address challenges that exist in the field. We define a systems approach as the combination of systems thinking and systems-development lifecycle:

- Systems thinking – holistic, not reductionist perspectives when conceiving solutions, to ensure proper accounting for the upstream, downstream, and collateral interdependencies among culture, workflow, policy, economics, technology, etc. involved in the field; and
- Systems-development life-cycle – thorough understanding of the problem to be solved, and methodical process for the conceptualization and the realization of its solution, while accounting for the needs of all relevant stakeholders.

Furthermore, at some point, questions of costs, benefits, and value will emerge. These are not just financial in nature, but also include patient outcomes and provider well-being. In addition, business models and stakeholder incentives must align with overall objectives and realities. Any prospective solutions must be evaluated with these systemic perspectives in mind.

Our goal is to equip graduates with solid understanding of the systems approach, and with the ability to adapt and tailor the application of this knowledge to their current positions and to use it as a springboard to use this knowledge to spearhead change from leadership positions as their careers grow.

Our current cohort in the program is a mix of healthcare professionals (administrators and clinicians) and others with backgrounds in science and engineering. We would like to see government and policymakers join us in making the healthcare system more effective, more efficient, and more resilient to stress.

Find further information on the website

SYSTEMS ENGINEERING SAMPLER

Selected examples of Systems Engineering in theory and in practice

BLOG: Seven Trends to Watch in 2021

From Rosalyn Tan, IIBA

This blog from the International Institute of Business Analysis (IIBA) explores opportunities for business-analysis professionals in the face of changes driven by the global pandemic.

The need for global connectedness has never been greater, and organizations' need for technology-assisted capabilities – combined with an increasing consumer appetite for on-demand services, greater transparency, and accessibility – have resulted in accelerated digital transformation, growth of the product owner role, widespread adoption of agile, greater emphasis on data-driven forward planning, and greater awareness of the importance of cybersecurity.

Read the blog

INTERVIEW: "Using 'Systems Thinking' to Make Sense of the World"

An Interview with Zeynep Tufekci, Associate professor, University of North Carolina (USA) School of Information and Library Science, Author of the Insight Newsletter

By Hilary McQuilkin and Meghna Chakrabarti

On Point, WBUR Public Radio, Boston, MA USA February 25, 2021

Overview: Why do we try to tackle the most complex problems of modern life in such a piecemeal fashion? From pandemics to politics, we discuss whether shifting to "systems thinking" can unlock hidden solutions to the world's biggest problems. "It's looking at the world as the interdependent, complex thing that interacts with each other over time that it is… It basically is looking at the world the way it really is, which means that there is many things moving at once. They do not happen according to the way we have our academic discipline set out."

Access the interview

WEBINAR: Negotiation, Persuasion, and Conflict for Systems Engineering

Did you know:

- Conflict is the engine that drives innovation and that it should be managed rather than resolved?
- INCOSE's Competency Model lists "negotiation" as a competency essential to requirements management, verification and validation, and acquisition and supply?
- Problems with conflict, persuasion and negotiation can be handled using skills and techniques that can be easily learned and, with practice, applied in many aspects of your professional and private life?

The Chesapeake Chapter of INCOSE sponsored a Webinar on March 19, 2021, titled "Negotiation, Persuasion, and Conflict for Systems Engineering." Zane Scott, Vice President for Professional Services for Vitech Corporation, provided a half-day presentation that addressed the importance and value of active listening, the use of communication, influence, and interest-based problem solving in professional and personal settings.

Access the recording, paper, and slides

PRESENTATION: "Interface Management – The Neglected Orphan of Systems Engineering"

Paul Davies, CSEP
2015 INCOSE Founders Award Recipient

Chesapeake Chapter of INCOSE
February 2021

Every interface is an opportunity to lose information, time, control, and/or money through contention between stakeholders at either end. There are many issues surrounding Interface management, and PPI's Paul Davies explores some of the characteristics of this missing material, and strings together some of the key concepts in best practice.

After noting the human and organizational barriers, Paul suggests that many of the systems engineering standards, guides, and textbooks fall short of providing a complete discussion of interfaces. These may well be lulling us into a false sense of security, because "we cannot see the pink rhinoceros in the room". He recommends eight best practices that should be considered while performing analysis, design, and testing of interfaces.

Download Paul Davies' briefing slides

Read about Paul's book, "Don't Panic: The Absolute Beginner's Guide to Managing Interfaces"

PRESENTATION: "Systems Engineering Evidence in Commercial Kitchens"

James R. Armstrong (jimarmstrong29@aol.com)
Stevens Institute of Technology

30th INCOSE International Symposium
July 18-23, 2020

Abstract: INCOSE has expressed interest in the application of systems engineering principles and practices in industries outside of the classic aerospace, communications, and other large system developments commonly related to the discipline. In this case, a visit to the kitchen at the Inn at Little Washington triggered thinking about how and why it was so different from other commercial kitchens. The resulting analysis of how systems engineering has significant relationship to the design of a wide variety of commercial kitchens is provided in this paper. The objective is to learn how we can see systems engineering in places it isn't normally found to both find other ways it can be applied and to help others improve their results by using systems engineering discipline.

View the Presentation

JOURNAL: Systems Engineering, Featured Papers of 2019

Wiley and INCOSE have collaborated to publish a special edition of the journal *Systems Engineering, Featured Papers of 2019*, selected by the editors. You will find topics on:

- Agent-based model for improved system-of-systems decision-making
- Methodology for the system integration of adaptive resilience
- Architecting a portfolio of systems
- Applying standard-independent verification and validation techniques within an agile framework
- Method of identifying and analyzing irrational behavior in a system of systems
- Mission-based architecture for swarm-based unmanned systems.

Take advantage of this opportunity to learn more about the latest in systems engineering developments while this issue is available online as free-to-read for the next two months.

Access the Journal

ARTICLE: Enterprise Architecture Framework in a Nutshell

This article provides an overview of architectural frameworks. An enterprise architecture (EA) is a conceptual blueprint for conducting enterprise analysis, design, planning, and implementation using a comprehensive approach, for the successful development and execution of strategy.

The purpose of enterprise architecture is to determine how an organization can most effectively achieve the current and future objectives of its business goals. Each enterprise architecture involves governing principles that drive an ongoing discussion about business strategy and how it can be expressed through IT. Enterprise architects are professionals who manage each structure to ensure that IT systems are aligned with ongoing business strategies and standards.

Read the Article

WHITE PAPER: Designing Fluid Control Components in a Virtual Environment

This paper details how Valcor Engineering Corporation uses Model-Based Systems Engineering (MBSE) to enable its engineers to design complex electromechanical systems by creating a "digital twin" of new fluid-control components. MBSE is used to design, evaluate performance, verify conformance to customer specifications, and optimize manufacturability before a single part is fabricated. Once actual physical production is underway, actual test data creates a feedback loop to the theoretical model, allow further refinement of tools, analysis, and design.

Read the White Paper

ORGANIZATION: Systems Engineering Research Center (SERC) (USA)

The Systems Engineering Research Center (SERC) is a University-Affiliated Research Center of the US Department of Defense. It leverages the research and expertise of senior lead researchers from 22 collaborator universities throughout the United States. The SERC is unprecedented in the depth and breadth of its reach, leadership, and citizenship in systems engineering through its conduct of vitally important research and the education of future systems engineering leaders.

Begun in 2008 and led by Stevens Institute of Technology, the SERC is a national resource providing a critical mass of systems engineering researchers – a community of broad experience, deep knowledge, and diverse interests. SERC researchers have worked across a wide variety of domains and industries and bring a wide-ranging wealth of experience and expertise to their research. The community of focused systems engineering (SE) researchers delivers impact well beyond what any one university could accomplish.

Mission: The SERC will be instrumental in developing partnerships between academia, government, and industry with a focus on solving systems challenges that are critical to our national security through systems research. In doing so, the SERC will:

- Catalyze community growth among SE researchers and end users, by enabling collaboration among many SE research organizations.
- Accelerate SE competency development through rapid transfer of its research to educators and practitioners.
- Transform SE practice throughout the government, by creating innovative methods, processes, and tools that address critical challenges to meet mission outcomes.

Vision: The SERC is the networked national resource in the United States, meeting systems challenges of national and global significance through systems research.

SERC Website

ORGANIZATION: Korea Council on Systems Engineering (KCOSE)

Korea Council on Systems Engineering (KCOSE) was established in February 2002. KCOSE is a meeting place for system engineers from industry, academia, research, and government agencies to develop system engineering technology. Robert Halligan, PPI Managing Director, assisted in the formation of KCOSE and is an Honorary Member.

English translation of the KCOSE Website

ORGANIZATION: Institute of Industrial and Systems Engineers (IISE)

Industrial and systems engineers make things better in any industry — from automobile manufacturing and aerospace, to healthcare, forestry, finance, leisure, and education. The Institute of Industrial and Systems Engineers, founded in 1948, helps its members improve complex organizations around the world and across industries. Throughout their careers, members turn to IISE for tools and connections that provide an integrated and systemic perspective to business challenges. Solving complex problems is our common objective.

IISE, the world's largest professional society dedicated solely to the support of the profession, is an international, nonprofit association that provides leadership for the application, education, training, research, and development of industrial and systems engineering.

What is industrial and systems engineering? (IISE official definition)

Industrial and systems engineering is concerned with the design, improvement, and installation of integrated systems of people, materials, information, equipment, and energy. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design, to specify, predict, and evaluate the results to be obtained from such systems.

IISE is recognized internationally as:

- The leading provider of cutting-edge continuing education in industrial and systems engineering.
- The acknowledged source of productivity improvement information via the Internet, publications, and live events, including an annual conference, topical conferences, and technical seminars.
- An invaluable source of member benefits that include the award-winning *ISE magazine*, professional development programs, an online career center, networking communities, chapters, and affinity programs that save members time and money.
- The only association that supports the profession of industrial and systems engineering and promotes an increased awareness of the value of industrial and systems engineers.
- The only association that supports accredited industrial engineering programs through ABET Inc.

IISE Website

ORGANIZATION: National Defense Industrial Association (NDIA)

The National Defense Industrial Association (NDIA) in the United States drives strategic dialogue in national security by identifying key issues and leveraging the knowledge and experience of its military, government, industry, and academic members to address them.

NDIA, composed of its Affiliates, Chapters, Divisions, and 1,560 corporate and 52,700 individual members, is a non-partisan, non-profit, educational association and was founded to educate its constituencies on all aspects of national security.

NDIA formed from a merger between the American Defense Preparedness Association, previously known as the Army Ordnance Association, founded in 1919, and the National Security Industrial Association, founded in

1944. For more than 100 years, NDIA has provided a platform through which leaders in government, industry, and academia can collaborate and provide solutions to advance the national security and defense needs of the nation.

NDIA Website

ORGANIZATION: European Space Agency (ESA)

The European Space Agency (ESA) is an intergovernmental organization of 22 member states dedicated to the exploration of space. Established in 1975 and headquartered in Paris, ESA had a worldwide staff of about 2,200 in 2018 and an annual budget of about €6.68 billion in 2020.

System engineering and project management play a vital role in support of ESA's mission to shape the development of Europe's space capability and to ensure that investment in space continues to deliver benefits to the citizens of Europe and the world.

ESA Website

STANDARD: ISO/IEC/IEEE 15288:2015

Systems and software engineering — System life cycle processes

ISO/IEC/IEEE 15288:2015 establishes a common framework of process descriptions for describing the life cycle of systems created by humans. It defines a set of processes and associated terminology from an engineering viewpoint. These processes can be applied at any level in the hierarchy of a system's structure. Selected sets of these processes can be applied throughout the life cycle for managing and performing the stages of a system's life cycle. This is accomplished through the involvement of all stakeholders, with the ultimate goal of achieving customer satisfaction.

ISO/IEC/IEEE 15288:2015 also provides processes that support the definition, control and improvement of the system life cycle processes used within an organization or a project. Organizations and projects can use these processes when acquiring and supplying systems.

ISO/IEC/IEEE 15288:2015 concerns those systems that are man-made and may be configured with one or more of the following system elements: hardware, software, data, humans, processes (e.g., processes for providing service to users), procedures (e.g., operator instructions), facilities, materials and naturally occurring entities.

More Information

EDUCATION & ACADEMIA: Dawood University of Engineering and Technology [Karachi, Sindh, Pakistan]

Dawood University of Engineering & Technology aims to invest in human capital for accelerated advancement in engineering knowledge and practices, new frontiers in R&D, creating a knowledge led economy and a better future for generations to come.

The Computer Systems Engineering program of Dawood University is diverse and according to the needs of the modern trends. The program is accredited by Pakistan Engineering Council.

The vision of the Department is to be a pivotal element in the field of Computing by producing "research-oriented" graduates, who not only strengthen the country's professional manpower but become an integral component of every industry.

The program objectives are:

- To equip graduates with the fundamental knowledge and the technical skills in the relevant and connected areas of the field.
- To prepare graduates with a thorough background to work professionally in local and international environments.
- Producing graduates to apply mathematical and engineering knowledge in designing,

identifying, and solving engineering problems.
- To train graduates so that they progress through an advanced degree in engineering and other professionally connected areas.

More Information

EDUCATION & ACADEMIA: Online Master's Degree in Systems Engineering, Pennsylvania (USA) State University

The systems engineering program is an interdisciplinary degree and involves the identification, modeling, analysis, architecture, integration, and management of complex systems and processes. Systems engineering applies to many types of systems — large systems such as power plants, small systems such as circuit components, or computer hardware and software systems.

Penn State's online Master of Engineering in Systems Engineering program helps engineering professionals from diverse fields better understand how to manage complex engineering systems and improve future processes. The two-year schedule offers a convenient way for you to add a master's degree to your résumé while you work. Upgrading your knowledge and abilities is key to advancement, and the Penn State World Campus systems engineering master's degree program lets you do that on your time. Graduates have become lead engineers, principal engineers, engineering managers, and project managers in fields such as aerospace and aviation, government and defense, and manufacturing.

These features set Penn State's online Master of Engineering in Systems Engineering program apart:

- The systems engineering program will show you how to implement key systems engineering concepts to help you increase your effectiveness in your current job and open opportunities to advance in your career.
- The courses are taught by the same Penn State faculty who teach on campus. They bring real-world experience to the classroom and have been trained to teach in the online environment.

The program consists of 12 courses (36 credits) taken over six continuous semesters, with each semester containing two 7-week terms. The courses cover identification, modeling, analysis, architecture, integration, and management of complex systems and processes. You will also gain experience with project and program management, quality improvement initiatives, and creativity and problem solving. This interactive and collaborative cohort program helps students build strong ties with others and gain perspectives from other disciplines and industries.

More Information

EDUCATION & ACADEMIA: University College London Centre for Systems Engineering (UCLse)

The UCL Centre for Systems Engineering (UCLse) offers three postgraduate master's-degree programs with some common elements and some elements specific to each program:

- Systems Engineering Management
- Management of Complex Projects
- Technology Management

The UCLse invites applications for PhDs in Systems Engineering, Technology Management, and Project Management.

- The program typically consists of three to four years' full-time study, with some taught courses offered throughout the course (particularly in the first year).
- It is expected that PhD graduates have as their goal an academic career as a faculty member in a leading university, or to be an expert in systems engineering while continuing their industrial role.
- PhD applications are reviewed once a completed application form and research proposal have been submitted to the UCL

Admissions Office. They are not able to accept CVs or any other document without a completed application form.

UCLse has extensive experience in space-systems engineering through the Department of Space and Climate Physics. Students in degree programs benefit from industry-derived experience coupled with academics.

More Information

SYSTEMS ENGINEERING WEBSITES

Online Browsing Platform (OBP)

The Online Browsing Platform (OBP) provides search-based access to the most up to date content in ISO standards, graphical symbols, codes and terms and definitions. Content can be previewed, search within documents is provided, and it is possible to navigate between standards.

Software and Systems Engineering Vocabulary (SEVOCAB)

A project of the IEEE Computer Society and ISO/IEC JTC 1/SC7, the SEVOCAB website provides definitions for software and systems engineering terms from ISO, IEEE, and PMI international standards. You can search for definitions of a term from the standards, or for all the definitions in a source standard. To provide an understanding of related concepts, SEVOCAB will return not only any definitions for the term, but also all the definitions that use the term.

The Ultimate Guide to Digital Transformation

This in-depth guide explains what digital transformation is, why it is important and how enterprises can successfully transition to this new business paradigm. Emerging technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), robotic process automation (RPA), and edge computing open entirely new business opportunities and give rise to completely new customer expectations. Companies with the resources and mindset to take the leap gain a competitive advantage, widening the gap between digital laggards and leaders.

IEEE CSS TC-CACSD Software Resources

This webpage lists computer-aided tools developed by researchers for tackling control and optimization problems in the design of control systems.

Feedback Systems wiki

This website is a wiki around *Feedback Systems: An Introduction for Scientists and Engineers* [Second Edition], by Karl J. Åström and Richard M. Murray. Many great resources on Feedback Systems, with examples and exercises on system modelling, dynamic behavior, linear systems, state feedback, and more.

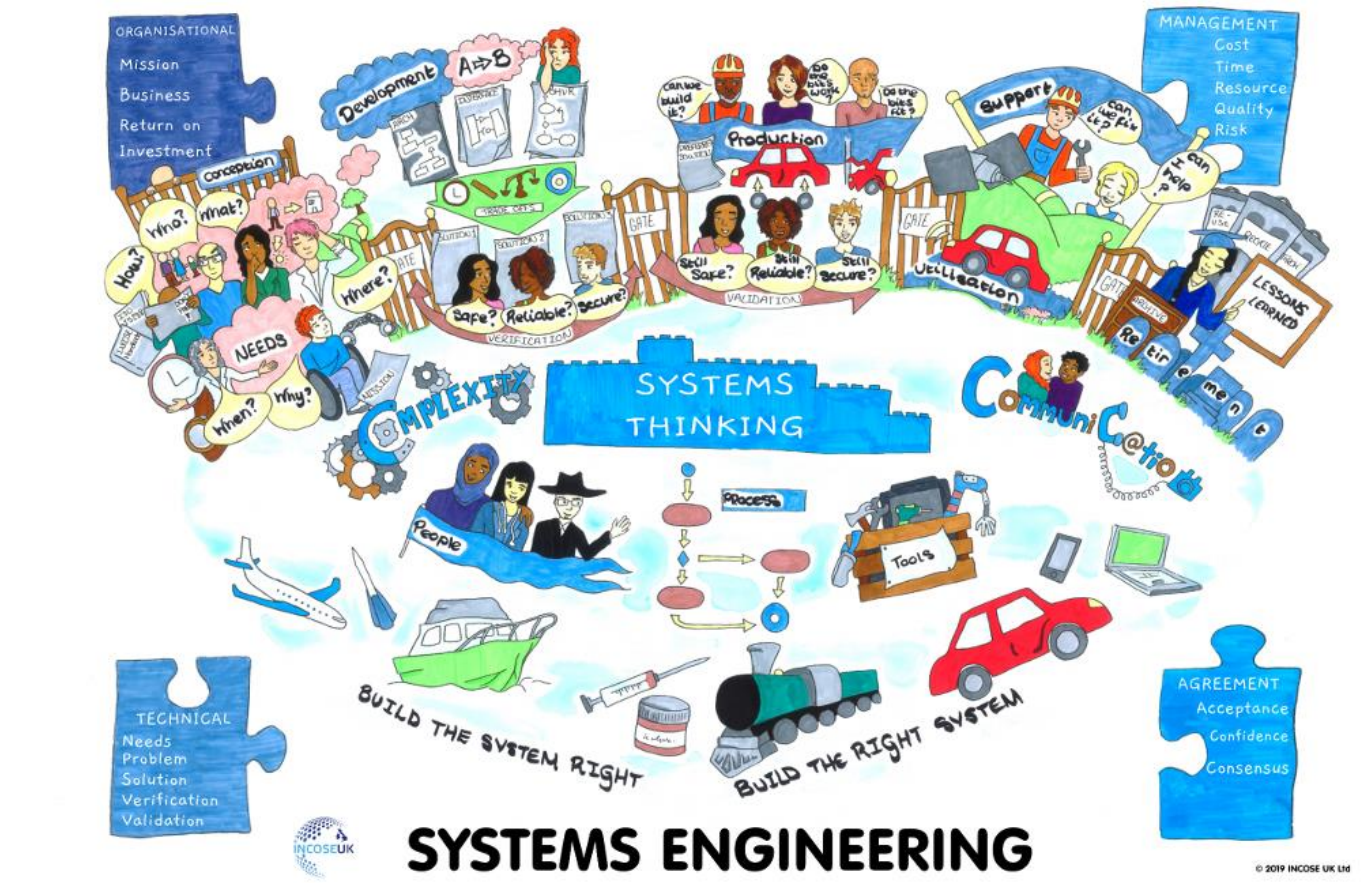
Control Tutorials for Matlab & Simulink

This website has loads of materials, tutorials and application on System, Modelling, Analysis, Control, PID, Root locus, etc.

Advanced Process Monitor

Advanced Process Monitor (APMonitor) is optimization software for mixed-integer and differential algebraic equations. The AP-Monitor modelling language is a high-level abstraction of mathematical optimization problems.

SYSTEMS ENGINEERING RESOURCES



POSTER: Systems Engineering

We live in a world where the complexity of our systems, whether they are technical, social, financial or anything in between, is constantly increasing. This is not only true at a system level due to the increased interactions and dependencies between system elements and the blurring of traditionally hard boundaries, but also at a higher level due to the fact that we now live in a truly connected world. Systems engineering describes an approach for realizing successful systems in an increasingly complex world. Visit the INCOSE UK Store

PAPER: Systems Engineering Perspectives on the 2500-year-old "Art of War" by Sun Tzu

Have you ever wondered, just how old are the ideas that underpin interdisciplinary, holistic systems engineering? This paper details how some of the fundamental thinking, philosophy, and approaches of systems engineering are deeply embedded in the classical, 2500-year-old "Art of War" by Sun Tzu. The author explores how many familiar definitions and concepts of systems engineering, including subsystems within a system and "quantifying" information, have long been recognized as important. Corporate-strategy processes in the ASEAN region, as inspired by the "Art of War", are compared with seven facets of systems engineering.

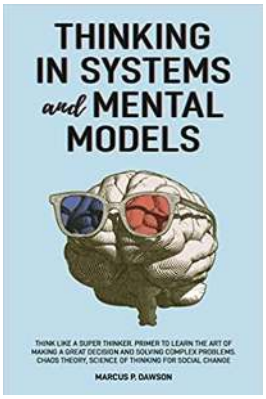
More Information

[Source: INCOSE.org]

PAPER: Advancing systems engineering for systems-of-systems challenges

Organizations, their capabilities, and their systems evolve, and those evolutions occur in a context of Systems-of-Systems (SoS). This paper examines the SoS challenges to the application of Systems Engineering (SE) in organizational evolutionary development and discusses the difference between "developing a SoS" and "developing systems in a SoS context" from an SE-management perspective. It presents a new approach to organizing and managing SE processes to cope better with high complexity and to improve architecture.

More Information



BOOK: Thinking in Systems and Mental Models: Think Like a Super Thinker.

Primer to Learn the Art of Making a Great Decision and Solving Complex Problems. Chaos Theory, Science of Thinking for Social Change

By Marcus P. Dawson

Just as every node on a network contributes to the final result, every action of a member of a particular organizational system contributes to the outcome. Without a broad view of interconnectedness, our problem-solving skills are limited and short-sighted, and our abilities to make long-term, beneficial decisions are hampered. If we only look to the immediate and the superficial, we forget that we rely on the smallest of parts. If we don't acknowledge our interdependence's complexity, then we are doomed to replicate a system that will ultimately fail. Awareness of our interconnectedness is key to solving the biggest and most complex problems we face in contemporary society.

The real question is not whether we should use systems thinking, but which of the many ideas, approaches, and techniques currently associated with the field of systems thinking are most useful in specific settings. In 1943, Kenneth Craik, a Scottish psychologist, explained that the human mind expects events and describes fundamentals by building small-scale models of the real world. A mental model is a way we represent and understand an event, phenomenon, or system compactly. There is a mental model for everything that happens around you.

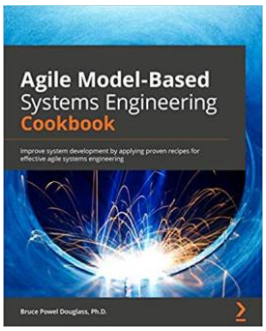
In this book, you will learn:

- The key concepts of systems thinking
- How to solve any problem with a step-by-step method
- Tips to improve your decision-making process
- The role of Chaos Theory in systems thinking
- What is wrong with your current way of thinking, and how you can improve it
- Strategies for developing habits, mental toughness, and resilience to combat mental clutter
- 40 mental models that you can use in your daily life
- Identify the mental models you already use every day
- How to expand your set of mental models, create new ones and use them effectively

Systems thinking provides a framework for defining and solving problems. Start by paying attention to the questions you ask to practice thinking from a more systemic perspective. Extend your sense of what constitutes "the present." Try to think as "now" in terms of a more extended block of time. Ask yourself what happened just a year ago. What is going on now? What happened last year? We can grasp interconnections that we may not have seen before by extending our sense of the "now."

More Information

[Source: Amazon.com]



BOOK: Agile Model-Based Systems Engineering Cookbook

By Bruce Powel Douglass

Model-based systems engineering provides an integrated approach to creating verifiable models of engineering data, rather than relying on traditional and vague natural language descriptions that are difficult to verify. This enables one to work on accurate specifications and rapidly design reliable and effective products for the marketplace. Agile MBSE integrates the value proposition of agile methods in systems development, most notably, for managing constant change and uncertainty while continuously ensuring system correctness and meeting customers' needs.

Written by Dr. Bruce Douglass, a world-renowned expert in MBSE, this book will take you through important systems engineering workflows and show you how they can be performed effectively with an agile and model-based approach. The book begins with key agile method concepts for systems engineering. It then takes you through initiating a project, defining stakeholder needs, defining and analyzing system requirements, designing system architecture, performing model-based engineering trade studies, and handing systems specifications off to downstream engineering.

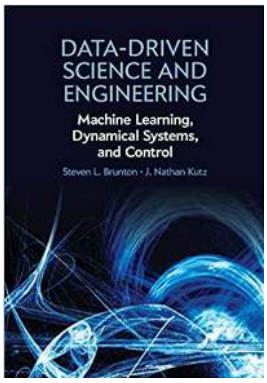
By the end of this MBSE book, you'll have learned how to implement critical systems engineering workflows and create verifiably correct systems engineering models.

What you will learn:

- Apply agile methods to develop systems engineering specifications
- Perform functional analysis with SysML
- Derive and model systems architectures from key requirements
- Model crucial engineering data to clarify systems requirements
- Communicate decisions with downstream subsystem implementation teams
- Verify specifications with model reviews and simulations
- Ensure the accuracy of systems models through model-based testing
- Model performance, throughput, security, safety, and reliability requirements

More Information

[Source: Amazon.com]



BOOK: Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control

By Steven L. Brunton and J. Nathan Kutz

Data-driven discovery is revolutionizing the modeling, prediction, and control of complex systems. This textbook brings together machine learning, engineering mathematics, and mathematical physics to integrate modeling and control of dynamical systems with modern methods in data science. It highlights many of the recent advances in scientific computing that enable data-driven methods to be applied to a diverse range of complex systems, such as turbulence, the brain, climate, epidemiology, finance, robotics, and autonomy. Aimed at advanced undergraduate and beginning graduate students in the engineering and physical sciences, the text presents a range of topics and methods from introductory to state of the art.

More Information

[Source: Amazon.com]

DEFINITION: Object-Oriented Systems Engineering Method (OOSEM)

Originally developed by systems engineers from Lockheed Martin and the Systems and Software Consortium, the Object-Oriented Systems Engineering Method (OOSEM) is a systems-level development method that combines object-oriented concepts with traditional systems engineering practices. Two major goals of the method are to facilitate integration of systems engineering with object-oriented (OO) software engineering, and to apply OO modeling in a way that benefits the systems engineering process.

OOSEM was originally based on the Object Management Group (OMG) Unified Modeling Language (UML); it now uses the OMG Systems Modeling Language (SysML) to represent systems analysis and design information. It contains activities for needs and requirements analysis, logical and allocated architecture design, and includes guidance for trade studies, validation, and verification.

[Source: INCOSE]

YouTube video explaining OOSEM

DEFINITION: Triple Constraint

In project management, the triple constraint is a model that describes the three most significant restrictions on any project: scope, schedule, and cost.

The triple constraint is sometimes referred to as the project management triangle or the iron triangle. In the typical triangular model, scope, schedule, and cost are constraints that form the sides of the triangle, with quality as the central theme. (An alternative to the triangle, the project management diamond, adds quality as the fourth side of the model and changes the central theme to customer expectations.)

The three constraints are interdependent: None of them can be altered without affecting one or both of the others. For example, if the scope of a project is increased, it is likely to take longer and/or cost more. Likewise, an earlier deadline is almost certain to either require more money or a less ambitious scope.

The difficulty of satisfying expectations for all three constraints is sometimes expressed as "pick two": the concept is that in any set of three desired qualities, only two can be delivered. If, for example, clients want to keep the budget low, the product is likely to take longer or be of lower quality.

[Whatis.com "Word of the Day", March 19, 2021]

PPI SYSTEMS ENGINEERING GOLDMINE

The PPI Systems Engineering Goldmine is a free resource that contains a wealth of reference information relevant to the engineering of systems.

SE Goldmine features include:

- Thousands of engineering and project-related downloadable documents (4GB+)
- Searchable database by description, title, keywords, date, source, etc.
- Extensive library of standards, and links to standards
- Searchable systems engineering-relevant definitions, 7800+ defined terms

Registration is required for access to these resources.

More information and registration

DID YOU KNOW?

Project Performance International (PPI) offers a wide range of live, on-line training to align with local time zones worldwide.

Topics include:

- Systems Engineering
- Requirements and Specifications
- Project/Engineering Management
- Design
- Medical Device Risk Management
- Software Engineering

Learn more about PPI training

FINAL THOUGHTS

Syenna's Corner

If you are reading this, then the editors of PPI SyEN must have courageously allowed me to try out an experiment with you. The idea is to reserve a regular corner for some light-hearted moments amongst the more erudite contributions to this publication. Although opt-out clauses are now illegal in the European Union, I'd like to carry on with it until the protests are deafening. I'd also welcome your contributions, in which case please send them to PPISyEN@PPI-Int.com, including "Syenna's Corner" in the subject line. Alternatively, please email the same address with "Ban Syenna" in the subject line.

I'd like to kick things off with the following article that I wrote on 1st April of this year, which of course is by now an oxymoronic April fool. I'm pleased to say that at least 1.25 people were taken in by it before that noon.

We all know about genetic mutation and survival of the fittest. A recent scientific study showed an example of this phenomenon developing at an unprecedented pace. The lead author, Professor Terence Humb, stated, "We normally expect evolutionary changes to take thousands of years, but here we have one with a timescale of decades or less". A previously rare condition, dubbed "loose thumb", is now to be found in over 1% of people under the age of 40.

The technical term for this condition is "abductor pollicis mobili" (APM). Sufferers have very loose thumb joints that allow the thumb to be rotated through angles of almost 360 degrees in all axes.

Professor Humb explains that, although the opposed thumb is reckoned to give humans a significant advantage over other species, APM undermines that advantage because it reduces the ability to grip things properly.

An article headed "Fastest Thumb First" in *Lance-It* supports the theory that APM provides significant social advantage in today's device-dominated world. So far, there has been no credible explanation for the extraordinary pace of this development, which some sources are calling "Hyper-Darwinism".

The theory has been dismissed by Dr. Sharon Peak, an expert in human-machine interface design who works for HMI Works Ltd. in Brighton, U.K.

In her opinion, "Using our thumbs to interface to smart devices is probably one of the worst human-machine-interface designs ever conceived. Billions of people have been conned into buying these devices. In less than a decade, voice interfaces will be the norm, following which direct brainwave scanning will tell our devices what we are thinking. All these people with APM will be dropping their knives and forks into their dinner and wishing that they had learned to speak with better diction."

If you are still reading, then thank you for your sufferance.

Yours faithfully, and ever grateful that my parents named me after your splendid newsjournal,

Syenna

Syenna Margaret Puck is a free-lance journalist, social-media influencer, and figment of some overactive imagination. She lives and works in Europe.

FEEDBACK

Should PPI SyEN:

- Dedicate a corner to Syenna?
- Make Syenna sit in a corner until she promises to do better next time?
- Ask Security to escort Syenna from the building and to clean out her corner?

Share your thoughts with us via email:
PPISyEN@PPI-Int.com