PPI SyEN

SYSTEMS ENGINEERING NEWSJOURNAL EDITION 117 | OCT 2022

Making an Impact in Engineering

"WORK" BREAKDOWN STRUCTURE
Rules, standards, and advice

SYSTEMS ENGINEERING RESOURCES
Improve your SE effectiveness

SYSTEMS ENGINEERING IN SOCIETY
Expanding applications of SE globally

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PPI SyEN

EMAIL: PPISyEN@PPI-Int.com

EDITORIAL STAFF

Editor
John Fitch

Editor-in-Chief
Robert Halligan

Managing Editor
René King

PRODUCTION STAFF

Marketing Manager
Benjamin Bryant

Graphic Designer
Matthew Wong

Marketing Coordinator
Rebeca Carneiro

Publishing Assistants
Trudy King
Shalani De Silva

PUBLISHER

PROJECT PERFORMANCE INTERNATIONAL

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

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

www.ppi-int.com

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WELCOME

Welcome to the October edition of PPI SyEN!

I am ecstatic to welcome this month's edition with its theme, 'Making an Impact in Engineering'. This theme is close to my heart as I believe that engineers hold the key to shaping our future. In this month's Newsjournal, you can find some stepping stones to help expand your knowledge of systems engineering and to contribute to the body of knowledge through your own works. There are several conferences open for registration all around the world inviting new ideas, why not share your unique insights with the community? Have your pick among the wide range of conferences on systems engineering, ergonomics, human systems integration and more in 'Conferences, Meetings & Webinars'.

Fresh off the press, you can read about INCOSE's new Professional Development Portal that has just been released. Discover more about this INCOSE product and other relevant systems engineering news upfront within this edition. In addition, you can find out about some exciting developments within the SE society including mentorship opportunities, a new academic job opportunity and updates from standards organizations and the business analysis fields.

This month's feature article comes courtesy of PPI's Robert Halligan and is titled, 'Building a Great 'Work' Breakdown Structure'. Nailing your WBS/PBS sets you up for project success as the physical deliverables are specified, but how do we go about generating high quality WBS's? Read through this short and effective paper to find out.

It would not be PPI SyEN without a healthy dose of resources so make sure to bookmark the pages that tantalize your professional tastebuds in the resources section. Whether system dynamics is your passion, you're exploring digital engineering and digital twins or you would like to be involved in the Smart Cities development, there is sure to be something you will take interest in.

One of the inspirations for this month's theme was Prof. Bob Cryan's IET Presidential Address titled, 'Engineering leaders – holding the keys to the future of humanity'. This poignant video proposes that engineers view themselves as leaders and value the expertise of management and leadership skills just as highly as technical skills and then that they use those skills to uplift the younger generation of engineers. I highly recommend that you watch the video – the link is available to access in my reflections on the IET Presidential Address 2022 'SE in Society'.

I hope you enjoy this month's PPI Systems Engineering Newsjournal!

René

Managing Editor, PPI SyEN

PPI Systems Engineering Newsjournal (PPI SyEN) seeks:

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

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

SYSTEMS ENGINEERING NEWS

Recent events and updates in the field of systems engineering

INCOSE Launches Professional Development Portal (PDP)

The International Council on Systems Engineering (INCOSE) has announced the launch of the Professional Development Portal (PDP). INCOSE has developed and deployed the PDP for systems engineers and other professionals who want to enhance their systems engineering knowledge and skills.

The current capabilities of the PDP enable users to:

- Conduct a competency self-assessment based on the 5 competency groups (Core, Professional, Management, Technical, and Integrating) and 37 competencies defined in the INCOSE's System Engineering Competency Framework (ISECF) to help the user determine which learning resources to browse. For INCOSE members who have logged in, the assessment results are saved to their user profile. Results of non-member self-assesments may be printed.
- Browse and search the PDP Content Catalog to find learning resources. Over 700 learning resources are currently available, including INCOSE products, SE Handbook, textbooks, and SE mini-courses. Users may search the catalog by filtering on any combination of ISECF competency groups, competency topics, competency proficiency levels, SE application domains (Academia, Aerospace, …), SE process areas (Architecture Definition, Business or Mission Analysis, …), SEP experience areas (Acquisition and Supply, Architecture/Design Development, …) , SE attributes (Human-Systems Integration, Life Cycle cost, …) and SE general topics (Agile Systems Engineering, Artificial Intelligence, …). FAQs and Detailed Instructions are provided to assist users on the browsing process.
- Save browse/search results to the "bookshelf." Each user will have the opportunity to save the learning resource results from the browse / save function to their own bookshelf for later review. Users may add personal notes to any resource that has been saved to their bookshelf. Bookshelf FAQs are available.

PDP Home | Competency Self-Assessment | Browsing the Content Catalog | My Bookshelf

PDP capabilities and content will continue to grow as resources from INCOSE member organizations contribute their best practices and materials.

Don Gelosh, INCOSE Associate Director, Education and Training stated *"The Professional Development Portal has been a labor of love for the team who are behind the development, implementation and launch of this solution. Our aim has been to enhance and grow Systems Engineering capabilities worldwide. There is a continuous development plan for the PDP; if you have any suggestions or feedback, we would love to hear them."*

Access the PDP here. Use of Chrome or Microsoft Edge browsers is recommended.

Celebrating the 10th Anniversary of SEBoK

The systems engineering community is celebrating the 10th anniversary of the release of the Systems Engineering Body of Knowledge (SEBoK) V1.0. To mark this milestone, Nicole Hutchison, SEBoK Managing Editor, interviewed Dr. Art Pyster, the inaugural SEBoK Editor in Chief, about the history and future direction of the SEBoK.

The SEBoK provides a compendium of the key knowledge sources and references of Systems Engineering organized and explained to assist a wide variety of users. It was created by the Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE) project. BKCASE is overseen by a Governing Board, consisting of the International Council on Systems Engineering (INCOSE), the Systems Engineering Research Center (SERC), and the IEEE Computer Society. It is a living product, accepting community input continuously, with regular refreshes and updates.

View the Art Pyster interview here.
Access SEBoK V2.6 here.

INCOSE Chapter News 3Q2022

INCOSE chapters around the globe report continued progress toward their vision of promoting effective systems engineering practices across a diverse range of industries and system types.

The INCOSE Israel chapter (INCOSEIL) through its Human-Systems Integration (HSI) group continues to promote the symbiosis of systems engineering and human factors engineering through periodic lectures, workshops, and conferences. A recent well-attended hackathon encouraged the incorporation of human-system considerations into five transportation ventures, finding solutions to challenges in the field of smart transportation, and integrating systems and human factors engineering problems which arose in the field.

This summer the INCOSE Spain chapter (AEIS) launched multiple working groups, including Requirements, MBSE, Volunteering, and Complex Systems, Ontologies, and System Thinking (CSOST). AEIS has three new member institutions on the INCOSE Corporate Advisory Board (CAB): Universidad Carlos III de Madrid (UC3M), INDRA and CT Ingenieros.

INCOSE UK continues preparations for its Annual Systems Engineering Conference (ASEC2022) to be held on 22-23 November in Newcastle, UK. Keynote speakers include Laura Doughty and Mark Wild. INCOSE UK member Jessica Korzeniowska is top 100 finalist the Top 50 Women in Engineering Awards (WES50) in 2022.

The Japan Council on Systems Engineering (JCOSE):

- Hosted an online symposium (JS 2022) with keynotes by Sanford Friedenthal (*Moving Forward with SysML v2*) and Matthew Krause (*The Unified Architecture Framework: Creating Order out of Chaos*). Seven additional presentations supported the theme, "*Overcome complexity – Current Japan SE Examples and Latest Methods*".
- Collaborated with Society of Automotive Engineers (JSAE) to deliver a two-day introductory course on Systems Engineering for the Automotive Industry.

The new Board of Directors for INCOSE Brasil has prioritized the following goals for 2022, the chapter's 10th anniversary year:

- Establish/strengthen institutional relationships with companies, universities, and governmental organizations.
- Enable a proper knowledge-sharing environment
- Promote SEP Certification
- Increase volunteering engagement

The Brasil chapter has initiated regular meetings with two universities concerning systems engineering course content and held introductory meetings with Brazilian and international companies as part of INCOSE's CAB.

INCOSE Volunteer Opportunities

Professional organizations such as INCOSE depend on involvement of volunteers who take time away from their daily engagements and contribute their time and talents toward helping INCOSE achieve its vision. Leadership positions in chapters and at the international level offer members the opportunity to learn, develop, and practice leadership skills.

INCOSE is seeking candidates to fill several current volunteer opportunities:

- *Assistant Director, Early Career Professionals*: Appointed position with a three-year term of Office. The position reports to the Secretary. Long term, sustained memberships are vital to the wellbeing of any organization. INCOSE is no different in this respect. Members who are Early Career Professionals are strong candidates for active leadership in INCOSE and would benefit from a program focused on their interests and developing their potential. (Application Deadline: 30 November 2022)
- *Assistant Director, Membership Recruitment*: Appointed position with a three-year term of Office. The position reports to the Secretary. Long term, sustained memberships are vital to the wellbeing of any organization. INCOSE is no different in this respect. Successful recruiting of new members must involve clearly conveying the INCOSE value proposition including opportunities and how to maximize the benefits available with membership. (Application Deadline: 30 November 2022)
- *Assistant Director for Industry and Domain Outreach – Rest of the World*: Appointed position with a three-year term of office. This individual is responsible to the Director for Outreach for developing, maintaining, and implementing INCOSE's global strategy for outreach to the diverse domains of industry. There is an existing Assistant Director for Industry and Domain Outreach – USA. This role covers the same topic, but for areas of the world outside the United States of America. (Application Deadline: 31 December 2022)

View current INCOSE volunteer and paid opportunities.
View INCOSE opportunities on LinkedIn.

Intercax Syndeia 3.5 Released

Intercax has announced the release of version 3.5 of Syndeia™, a software platform for integrated model-based engineering that federates models and data from diverse ecosystems of modeling and simulation tools, enterprise applications, and data repositories.

Syndeia 3.5:

- Brings new integrations, including a generic RESTful Integration to connect to any enterprise tool or service that provides a REST API.
- Supports enterprise Single Sign On (SSO) services using SAML2 to authenticate Syndeia Web Dashboard users.
- Improves the Syndeia Cloud REST API support pagination and artifact attribute retrieval from integrated repositories.

Integrations added to or enhanced in Syndeia 3.5. include:

- VOLTA (ESTECO)
- Collaborator (SmartBear)
- RESTful Integration
- SysML v2 (OMG)
- XML (Managed on GitHub and Gitlab)
- Jama OAuth Support

See more details on Syndeia 3.5 here.
Download Syndeia 3.5 here.
Learn more about Intercax products and services.

Documents Added to PPI's Systems Engineering Goldmine

PPI's Systems Engineering Goldmine (SEG), contains a wealth of resources that have been assembled by the PPI team over multiple years. Documents recently updated or added to the SEG include:

A Set of Support Tools to Software Process Appraisal and Improvement in Adherence to CMMI-DEV
The purpose of this paper is to provide a set of support tools is to assist software organizations in the implementation of the CMMI-DEV model. It is expected that these tools will be readily adopted by software organizations because they are based on models and standards that are generally accepted. (Source: ICSEA/IARA Corporation, Inc.)

Advanced Meeting Agenda
The purpose of the agenda is to provide points of discussion such as problems, issues, information, etc., salient to the scheduled meeting. The agenda is an aid from which the participant can prepare for the meeting. (Source: Federal Aviation Administration (FAA))

Application and Reference Guidebook
This guidebook is addressed to the acquirer, that is, to an organization that procures software products for itself or for another organization. It can also be used by developers and other parties, but its focus is on helping the acquirer understand and apply MIL-STD-498. (Source: Joint Logistics Commanders Joint Policy Coordinating Group)

Depot Tools, Test Equipments and Materials List
This DID provide a listing of materials, hardware, and software tools required to support depot diagnostics of system software, all hardware, and all system interfaces. The listing will be used by the Government to determine the tools needed to provide depot maintenance and to support the system. (Source: Federal Aviation Administration (FAA))

Design Control Guidance for Medical Device Manufacturers
This guidance handbook is intended to assist manufacturers in understanding quality system requirements concerning design controls. Assistance is provided by interpreting the language of the quality systems requirements and explaining the underlying concepts in practical terms. (Source: FDA, Center for Devices and Radiological Health)

Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE)
The purpose of this Directive is, as a first priority, the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment, e.g. producers, distributors and consumers and in particular those operators directly involved in the treatment of waste electrical and electronic equipment. (Source: Official Journal of the European Union)

FAA Asset Identification Process and Procedure Guide
This guide was written to provide an easy to use "how to" tool to assist you in asset identification including barcoding, tagging, or identifying FAA personal property assets using FAA asset identification standards. It ensures FAA assets are properly identified and managed from the time the asset is initially acquired until it reaches the end of its life cycle and is disposed of. (Source: Federal Aviation Administration (FAA))

FAA Systems Engineering Manual
The purpose of this manual is to provide a framework for implementing systems engineering across the Federal Aviation Administration. (Source: Federal Aviation Administration (FAA))

Functional Procedure – Operational Concept Document
The purpose of the Operational Concept Document – Lite (OCDL) is to: describe a new or modified system in terms of the user needs it will fulfil, its relationship to existing systems and the ways it will be used; communicate the user's needs to the developer and other interested parties; obtain consensus among the End-user, acquirer, developer, support, and user agencies on the operational concept of the system and to provide a reference for determining 'fitness for purpose' of the system. (Source: Capability Acquisition and Sustainment Group)

Industrial and Systems Engineering Body of Knowledge
This Body of Knowledge Handbook draws upon specialised knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering and design, to specify, predict, and evaluate the results obtained from such systems. (Source: Institute of Industrial & Systems Engineering)

Integrated Product Support (IPS) Elements Guidebook
This guidebook is a Defense Acquisition University training asset to supplement and further explain implementation of new Product Support Manager guidance published by the Office of the Secretary of Defense. The focus is on the PSM Guidebook Appendix A, "Integrated Product Support Elements". (Source: Defense Acquisition University (DAU))

Integrated Project Team Start-up Guide
This Guide suggests how to set up, manage, and evaluate IPTs in government. It describes the most important decisions and key steps in IPT formation based on MITRE's research into best practices in industry and government as well as organizational behavior research on work team performance. (Source: The MITRE Corporation)

Introduction To Model-Based System Engineering (MBSE) and SysML
This presentation given at the INCOSE Delaware Chapter meeting, covers the Introduction to Model-Based System Engineering (MBSE) and SysML. Topics include: MBE/MBSE Terminology and Overview; SysML Overview; Object Oriented SE Methodology (OOSEM) and Modeling Tools and the Environment. (Source: Lockheed Martin Corporation)

Key Questions for Acquisition Success
This document contains a checklist of *Key Questions for Acquisition Success*, herein referred to as the "Checklist." The Checklist is intended to aid those responsible for formulating and/or executing a Federal Acquisition Program in improving the program's chance of success. It provides program managers, systems engineers, and contract specialists with important reminders and associated guidance that are applicable across a range of acquisition programs - large, major acquisitions and those leveraging agile acquisition methods. The document also includes affordability, efficiency, and effectiveness best practices.. (Source: MITRE Corporation and The Aerospace Corporation)

Leading Transformation of Model-Based Engineering: The Model-Based Capability Matrix
This presentation covers the Model-Based Engineering Capability and objectives. (Source: The Aerospace Corporation)

Lifecycle Modeling Language (LML) Specification
This Paper shows LML specification's purpose is to provide a reference for users of the language to understand its goals, concepts, and structure and to provide vendors a reference for implementation of the language. (Source: Life Cycle Modeling Organization)

LSST Verification & Validation Process & MBSE Methodology
This presentation relays the LSST Verification including planning, compliance assessments and validation process. (Source: Telescope MBSE SIG, Pasadena, CA)

Meeting Minutes (DID)
The purpose of Meeting Minutes is to provide a vehicle to report activities, accomplishments, issues, problems, risks, actions, status, etc., for in-service depot repair programs managed and administered by the Contractor. (Source: Federal Aviation Administration (FAA))

Mission Engineering Guide
This guide describes the foundational elements and the overall methodology of Department of Defense (DoD) Mission Engineering (ME), including a set of ME terms and definitions that should be part of the common engineering parlance for studies and analyses, building upon already accepted sources and documentation from the stakeholder community in the Office of the Secretary of Defense (OSD), Joint Staff, Services, and Combatant Commands. (Source: Office of the Under Secretary of Defense for Research and Engineering)

Navigating the Requirements Jungle
In this paper we try to shine some light on the kinds of requirements occurring in current embedded systems design processes. We present a set of categories together with real-life examples. For each of them, we briefly describe possible approaches towards formal modeling and automated verification of the respective properties. (Source: Faculty of Informatics, Germany)

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On the Mathematical Foundations of MACBETH
This Paper presents an up-to-date survey of the mathematical foundations of MACBETH. Reference is also made to real-world applications and an extensive bibliography, spanning back to the early 1990's, is provided. (Source: London School of Economics and Political Science)

Preparation of Specifications
This standard covers the format and content requirements for developing FAA specifications. (Source: U.S. Department of Transportation)

Reflections on the standardization of SysML 2
This paper reflects on a 2018 editorial entitled "Agile Model-Based System Development" [GR18c], in which several observations are reviewed. (Source: Springer, Corp.)

Systems Engineering Essentials
This lecture briefly identifies the value of Systems Engineering and justifies the development of Systems Engineering Competencies in your organisations. (Source: Loughborough University)

Systems Engineering Return on Investment
This presentation gives an outlook on Systems Engineering return on investments, covering topics on background motivation for the topic, goals and methodology and Research interim results with demographic and correlation results. (Source: University of Australia: Defense and Systems Institute)

The Tenth International Conference on SE Advances
This paper overviews the 10th international conference on Software Engineering Advances, following a series of events covering a broad spectrum of software related topics. (Source: ICSEA/IARA Corporation, Inc.)

UML and Function-Class Decomposition for Embedded Software Design
This paper introduces a practical application of the UML diagrams and function-class decomposition (FCD) concept to requirements analysis, software architecture analysis and design, and software design and implementation for a complex embedded system. (Source: Chai Kok-Soon, PhD Paper)

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

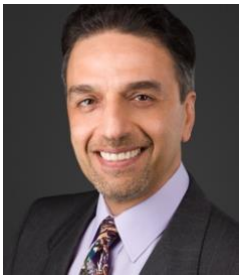
PPI Free Resource – Benchmark your SE Capability

Project Performance International has launched another FREE resource - the "Benchmark your (Systems) Engineering Capability" questionnaire! The questionnaire consists of 10 'Yes' or 'No' questions that will help you to evaluate your current systems engineering capability and identify any areas that may present opportunities for improvement.

By taking the questionnaire, you not only have greater awareness of your skills but will also discover how you can get to a 10/10!

The 'Benchmark your (Systems) Engineering Capability' resource is one of many other FREE resources that PPI offers for the systems engineering community. Access the full list of FREE resources here.

PPI's Bijan Elahi Presents at Philips SE Conference



On the 12 and 13 October, Medical Device Risk Management expert – PPI's Bijan Elahi, presented at the annual Philips Systems Engineering Conference. His talk titled, 'Can Risk Management Help You Succeed?' delved into how risk management can aid our companies with success by increasing our goodwill, having happier customers and employees and becoming more profitable.

An excerpt from the abstract of the presentation follows:

It goes without saying that safer products mean happier customers, trust in our products, and respect for our brand. Moreover, when risk management becomes part of the DNA of a company it leads to higher efficiency in product development by reducing rework, allowing clear and understandable work products, and reduced Field Corrective Actions. Employees are also happier when the risk management process is clear and unambiguous.

Connect with Bijan on LinkedIn: linkedin.com/in/bijanelahi

Are you interested in attending one of Bijan's trainings on Medical Device Risk Management? Register your interest via the following link.

CONFERENCES, MEETINGS & WEBINARS

INCOSE South Africa Conference

The INCOSE South Africa chapter will host its 16th annual Systems Engineering Conference on 14-16 November. The theme of this conference is "New Normal", focusing on applying systems thinking and systems engineering principles and processes within a disrupted and constrained environment.

The conference will be a virtual event over three full days. Each day will start with a plenary after which it will split into two tracks of paper and paperless presentations. After a late morning break there will be a panel discussion followed by further presentations in the two tracks. A lunch break, during which sponsors will be provided an opportunity to showcase their capabilities, will be followed with further presentations and a closing plenary.

Although the final program is being finalized, areas of emphasis include:

- Critical Infrastructure
- System of Systems (SoS)
- Emerging Technologies
- System Modernization
- Engineering Management
- System Resilience, Reliability, Safety
- Innovative Approaches: Agile, Iterative and Lean
- System Security Engineering
- Internet of Things (IoT) / Cyber-physical systems
- System Sustainment

Check for program updates and registration options here.

Registration and Keynotes for SERC-AIRC Annual Research Review

Registration is open for the Annual Research Review co-hosted by Systems Engineering Research Center (SERC) and Acquisition Innovation Research Center (AIRC). This hybrid (physical-virtual) conference will be held at the National Press Club in Washington DC on 15-17 November. The conference brings together sectors of the systems engineering and acquisition research communities – government, industry, and academia – and provides an opportunity to share progress on research addressing the most challenging issues facing the U.S. Department of Defense (DOD) and other federal departments and agencies.

This three-day event will begin with the AIRC (Acquisition Innovation Research Center) Sponsor Research Review on 15 November. The SERC Sponsor Research Review (SSRR) will be held on 16 November and the SERC Doctoral Student Forum (SDSF) will be held *virtually* on 17 November.

Keynote speakers for the 16 November SERC Sponsor Research Review are:

Charles Clancy, Ph.D., Senior Vice President, General Manager, MITRE Labs, Chief Futurist
Clancy is responsible for sparking innovative disruption, accelerating risk-taking and discovery, and delivering real-time technology capabilities and execution through the company's laboratories, solution platforms, and MITRE Fellows program. He leads technical innovation to anticipate and meet the future demands of government sponsors and industry and academic partners.

Kristen J. Baldwin, Deputy Assistant Secretary of the Air Force, Science, Technology and Engineering
Ms. Baldwin previously served as the Deputy Director for Strategic Technology Protection and Exploitation within the Office of the Under Secretary of Defense for Research and Engineering and as the DoD lead for maintaining technology advantage by mitigating exploitation and vulnerabilities of critical missions, programs, technologies, and the industrial base. Ms. Baldwin oversees program protection policy and related hardware and software assurance, anti-tamper, and critical technical information protection practices. She oversees the Joint Federated Assurance Center and leads DoD policy and standards for trusted and assured systems. She oversees the DoD National Manufacturing Institutes and the Manufacturing Technology program.

Learn more here.
Register here.

Human Systems Integration Workshop 2022

INCOSE is hosting the 2022 Human Systems Integration Workshop, HSI2022 in Torrance, California from 16-18 November. HSI Workshop 2022 will be a hybrid event. Sessions will be limited to 90 minutes to maintain a good level of attention for both participants attending in person and virtually.

The conference will feature:

- Three keynote lectures on contemporary Human Systems Integration topics such as situational awareness, human-machine teaming, and organizational automation
- Engagement around the status of the INCOSE HSI Primer
- Partnership activities with the Ergonomics Association (IEA)
- Collaboration opportunities with other INCOSE working groups

Learn more here. View updates to the HSI2022 conference program.
Register for HSI2022.

Registration Opens for Capella Days

Registration is open for Capella Days 2022, co-organized by OBEO and Thales. This free, online event scheduled for 15-17 November 2022. Capella Days provides an opportunity for knowledge sharing among members of the community of the Capella MBSE tool and Arcadia methodology. Presenters represent a diverse range of global organizations including Thales Defense Mission and Avionics Systems, Siemens Digital Industries Software, Thermo Fisher Scientific, ESI-TNO, CILAS - Ariane Group, COMAC, PGM, Saratech, Naval Group, and Politecnico di Milano.

Day 1 talks include:

- A global engineering process based on MBSE to master complexity
- A method for quantitative evaluation of functional chains supported by a Capella add-on

- Expand MBSE into Model-based Production Engineering (MBPE) to realize a Lego Manufacturing System

Day 2 presentations feature:

- How We Use Capella for Collaborative Design in COMAC
- Stairway to heaven: Climbing the very first steps
- CILAS feedback about Capella use

Day 3 concludes with these talks:

- Interface Control Document Generation and Linkage to PLM EBOM
- Closing the gap between traditional engineering and digital-native engineering at Naval Group
- Interplanetary Space Mission as a reverse-engineering background for the Capella environment

Learn more about Capella Days 2022. Register here.

Day of Systems Engineering – TdSE® 2022

INCOSE's German chapter, GfSE (Gesellschaft für Systems Engineering e.V) is hosting its annual conference, Day of Systems Engineering (TdSE®), in face-to-face format in Paderborn, Germany from 16-18 November. The theme of the conference celebrates "25 years of GfSE". Participants come from German-speaking countries and include project managers, innovation managers, systems engineers, or system architects.

Day 1 includes a diverse range of tutorials:

- Comparison of systems engineering and agile methods
- SpecIF - What is it?
- Viewpoints, perspectives and aspects as conceptual models and project planning tools
- Artificial Intelligence in MBSE
- Visual Engineering - use cases, methods, tools
- The system footprint – the visualized understanding of the system

Tool vendors will also share their MBSE insights:

- Smart requirements management in product development with ReqSuite® RM
- Holistic Variant Management according to the Product Line Engineering approach
- MBSE journey with CATIA Systems
- Consistent development processes with the CONTACT Elements platform
- Systems Engineering with the IBM Engineering Lifecycle Management Platform: MBSE at Speed
- SE is more than architecting - MBSE along ISO15288 and your business processes
- Management of a system lifecycle: From the ALM tool to the model to the code

Day 2 will begin with Jan Seyler's keynote address: *Generative System Design: Can AI build machines?* Concurrent presentations will be delivered across multiple Day 2 tracks:

- Sustainability & Model-Based Product Line Engineering
- Best practices in systems engineering

- Acceptance of stakeholder/human-technology integration
- Agility, Artificial Intelligence (AI) & Digital Twins in Engineering
- Networked Systems & System of Systems (SoS)

Dr. Lydia Kaiser will launch Day 3 with a keynote address, *Systems Thinking - The Magic of Systems Engineering*. Day 3 tracks include:

- Stakeholder-oriented/friendly (Model Based) Systems Engineering Methods & Tools
- Organizational design and compatibility Systems Engineering

Learn more about TDSE® 2022 here.
Register here.

Webcast: Design for Flexibility - a Human Systems Integration Approach

On 14 November, the INCOSE San Diego (California, USA) chapter will host a presentation by Dr. Guy André Boy, INCOSE Fellow and Chair of the INCOSE Human Systems Integration (HSI) Working Group. Both in-person and remote webcast options will be available. Dr. Boy will speak on *Design for Flexibility: a Human Systems Integration Approach*.

Synopsis: Although fortuitous, the coincidence of questions related to COVID-19 and the themes of my presentation will enable me to introduce this new discipline that is human systems integration (HSI) in a more tangible manner, in the sense that the management of the unexpected opens the field of risk taking seen from the angle of abduction. We will therefore deal with HSI in its broadest sense. HSI is at the crossroads of several disciplines, including psychology, social sciences, biology, mathematics, computer science and the engineering sciences. Models from these initial disciplines are already and will be selected and modified to form more integrated theories. The resulting basic framework will be used to propose solutions to improve the flexibility of our sociotechnical systems (e.g., medical systems, mobility systems, education systems, energy, defense and many others).

Learn more about the presenter, Guy André Boy, Ph.D.
Learn more and RSVP here.

Webinar: Comparison of the new Lean Healthcare Systems Engineering (LHSE) Process with former Quality Initiatives: Lean, Six Sigma, TQM, ToC, PDSA

On 8 November, the INCOSE Los Angeles (California, USA) chapter will host a free online presentation by Bo Oppenheim that will highlight the key concepts of a new Lean Healthcare Systems Engineering (LHSE) process. Bohdan "Bo" W. Oppenheim is a Professor Emeritus and Director (Retired) of Healthcare Systems Engineering graduate Program at Loyola Marymount University (LMU). Oppenheim is the author of seven books, authored and co-authored chapters in six other books and published 30 journal papers. He was honored with three Shingo Awards, INCOSE (International Council on Systems Engineering) Product of the Year Award, INCOSE Fellowship, and over $2 million in externally funded grants.

Abstract: A new process called Lean Healthcare Systems Engineering (LHSE) recently invented for improving healthcare workflows and designing new care is reviewed and compared to previous quality initiatives: PDSA, TQM, Six Sigma, Lean, Theory of Constraints, and several others. LHSE is

applicable to workflow improvement or new care design projects in clinical environments, including hospitals, operating suites, emergency departments, clinics, imaging and clinical laboratories, pharmacies, population health, and telemedicine.

LHSE integrates the strengths of Lean Six Sigma and Systems Engineering (SE). Lean's overarching philosophy of "do what is necessary to deliver the value and reject everything else as waste" governed the tailoring of the classical SE process to healthcare, eliminating the many bureaucratic and wasteful activities, and leaving only the steps that truly are needed in healthcare improvement projects. Utilizing tools from SE, LHSE presents several powerful improvements over previous approaches, in particular system optimization reducing the trial-and-error effort and cost; and increasing the predictability of outcomes. LHSE provides consistent logical rigor to projects, reducing iterations and failure, and is particularly effective in elimination the notorious fragmentation in healthcare systems. Although LHSE has been created for healthcare, it is a general process applicable to non-healthcare projects.

PPI features Dr. Oppenheim's foundational work on Lean Systems Engineering as part of our 5-Day Systems Engineering course.

A 63-page LHSE White Paper is available for download to attendees to prepare for this presentation. White paper contents include:

- Evolution of Process Improvement Initiatives (PDSA, TQM, Six Sigma, Lean, Lean Six Sigma, Theory of Constraints)
- Lean Healthcare Systems Engineering (SE, LHSE Process/Phases, LHSE Definition)
- Results, Discussions and Conclusions

Learn more and register here.
Learn more about the presenter, Bo Oppenheim.

Ergonomics 2022: 9th International Ergonomics Conference, Zagreb, Croatia

HRVATSKO ERGONOMIJSKO DRUŠTVO
CROATIAN ERGONOMICS SOCIETY

The Croatian Ergonomics Society is hosting the 9th International Ergonomics Conference (Ergonomics 2022) on 7-10 December in Zagreb, Croatia. Ergonomics 2022 is endorsed by International Ergonomics Association (IEA), Federation of the European Ergonomics Societies (FEES) and Acoustical Society of Croatia (ASC). The conferences in this series have been organized by Croatian Ergonomics Society since 2001, and traditionally bring together ergonomics enthusiasts, experts and scientists from all over the world.

The conference will be a hybrid event with a mix of:

- Live, on-site oral/poster presentations
- Real-time on-line oral presentations
- Pre-recorded oral presentations

Topics of interest will include:

- Aesthetics and Ergonomics
- Biomechanics and Modelling in Ergonomics
- Cognitive Ergonomics
- Education and Trainings in Work Safety and Ergonomics
- Ergonomics for People with Disabilities and Aging Population

- Ergonomics in Product and Process Design
- Ergonomic Regulations, Standards and Guidelines Healthcare Ergonomics
- Physical Ergonomics and Human Factors
- Human Comfort
- Safety and Risk Ergonomics
- Psychoacoustic Ergonomics
- Social and Occupational Ergonomics
- Traffic and Transport Ergonomics

View registration information.
Learn more and check on the evolving program here.

INCOSE IS2023 Call for Submissions

The International Council on Systems Engineering (INCOSE) has issued its Call for Submissions for the International Symposium 2023 (IS2023). IS2023 will be a hybrid event scheduled for 15-20 July 2023 with the in-person conference to be held in Honolulu, Hawaii, USA. For this premier global forum, INCOSE seeks a blend of papers, presentations, panels, and tutorials that reflect experiences, trends, issues, and innovations that advance practices and theory that will engage the symposium participants in active discussions.

Application domains	Areas of emphasis
• Automation and Smart Cities • Aerospace and Defense • Cybersecurity • Education & Training • Energy and Environment • Healthcare and Biomedical • Information & Technology • Socio-economics • Sustainable Technologies • Transportation and Automotive	• Agile, Iterative, and Lean • Autonomous Systems • Critical Infrastructure • Digital Engineering • Emerging Technologies • Engineering Management • Global Environmental Sustainment • Industry 4.0 and Society 5.0 • Innovative Approaches • Systems of Systems (SoS) • Systems Modernization • Systems Resilience, Reliability, Safety • Systems Security Engineering • Socio-economic Sustainment

Call for Papers
INCOSE encourages authors to submit high quality, close-to-final draft papers addressing systems engineering focused around the key domains and emphasis areas above. Ideally, a draft paper should cover the full scope of the issue. Academic papers should cover from theory to theory validation, although papers presenting research proposals coupled with initial results will also be considered. Practice-focused papers should include problem space and approach through implementation.

Papers must be original work that has not previously been published. Joint authors must nominate a single point of contact.

Accepted papers will be presented at the Symposium and will be published in the Proceedings of the Symposium and in the INCOSE Papers and Presentations Library.

Submitted papers must specify whether the presentation will be in person or virtual. Accepted paper presenters are required to register and attend IS2023.

Call for Presentations
Presentations provide the opportunity for practitioners to share their work, novel approaches, or interesting problems addressed without writing a formal paper. INCOSE encourages authors to submit detailed abstracts for high quality presentations addressing systems engineering focused around the key domains and emphasis areas above. Sessions are 40 minutes: 30 minutes for presentation with 10 minutes for Q&A.

Accepted presentations will be posted on the INCOSE Paper and Presentation Library but are not included in the Proceedings of the Symposium nor in the Wiley Online Proceedings Library.

Submitted presentations must specify whether the presentation will be in person or virtual.

Call for Panels
In the context of IS2023, panel broadly refers to a session of more than two individuals that is not accompanied by a formal paper. This may take the form of a traditional panel, a roundtable discussion, an open forum, or a debate. Panels should be either in person or virtual – no hybrid panels will be accepted.

Call for Tutorials
Tutorial proposals are sought for following types of classroom instruction:

- Professional Development Tutorial
- Advanced Technology Tutorial
- Best Practices Implementation

The proposal must not contain a sales presentation for the presenter or the presenter's company, and shall not contain proprietary data.

Submitted tutorials must specify whether the tutorial will be in person or virtual.

Key dates, common to all types of submissions, include:

- All Submissions Due: 14 December 2022
- Notification of Acceptance: 20 February 2023
- Authors Acceptance to Present: 31 March 2023
- Final Submission Due: 30 April 30 2023

Submitters are cautioned to carefully follow the unique guidelines and use the templates provided for each type of submittal. Download the relevant guidelines and templates here.

Download the IS2023 Call for Submissions.
Learn more about IS2023 here.

Call for Content: INCOSE EMEA WSEC 2023

The INCOSE Europe, Middle-East and Africa (EMEA) sector has issued its Call for Content for the Workshop and Systems Engineering Conference (WSEC). EMEA WSEC 2023 will be a hybrid event, scheduled for 24-26 April 2023, with the in-person conference to be held in Seville, Spain. The theme for EMEA WSEC is "*Engineering a Sustainable World*," focusing on the role the Systems Engineering community can play in achieving the United Nations Sustainable Development Goals (UN SDGs), targeting Societal Challenges and on highly complex/chaotic systems aligned with the INCOSE Vision 2035 for a better world.

Types of content being sought include:

- Papers: See Guidelines and Paper Template.
- Panel sessions: See Panel / Roundtable / Debate Preparation Guidelines.
- Tutorials: See Tutorial Preparation Guidelines.
- Paperless presentations: See Paperless Presentation PowerPoint Template.
- Workshop: See Workshop Application Form.

Important dates include:

- Full content due for papers, panel sessions and tutorials: 1 December 2022
- Abstracts due for paperless presentations: 15 December 2022
- Applications for workshops due: 28 February 2023

Download the EMEA WSEC 2023 Call for Content.
Learn more about EMEA WSEC 2023 here.

SWISSED22 Presentations Available

The Swiss Society of Systems Engineering (SSSE) is a non-profit organization formed in 2011 by a group of like-minded engineers, working across a broad range of industries, who share the passion of practicing, advancing, and promoting Systems Engineering (SE) principles. SSSE has been officially recognized as the Chartered Swiss Chapter of INCOSE (International Council on Systems Engineering).

SSSE hosted Swiss Systems Engineering Day 2020 (SWISSED22) on 12 September in Zurich. The conference theme was "From Design to Reality – Walking up the "V"

Presentations currently posted on the SWISSED22 website include:

- Keynote: A 2022 Update on V-Model Thinking (Tom Gilb)
- Think outside the box: Expand MBSE into Model-based Production Engineering (MBPE) to realize a Lego Manufacturing System (Chantal Sinnwell and Susan Faust)
- MBSE-aided reverse engineering of an Interplanetary Space mission (Davide Bellicoso et al.)
- Why Models Are Essential to Digital and Systems Engineering (Alan Moore and Sébastien Dupertuis)
- What You Always Wanted to Know About the Right-Hand Side of the Vee and Never Dared to Ask (David Endler)
- How hardware-in-the-loop test benches accelerate embedded systems development (Ivo Locher)

- Three Major Risk Areas of Iterative System Integration Approaches (Dieter Scheithauer)
- Verification and validation as drivers of development. (Marco Serra)
- 42 - The Hitchhiker's Guide to Requirements Engineering (Oliver Fels)
- Beware the informal requirement: A formal definition and its practical applications (Marco Chicherio)
- The need for Critical Thinking (Mike Johnson)
- New evidence on the RoI of Systems Engineering - a case study of NASA, COTS and SpaceX (Marc-Andre Chavy-Macdonald)
- Better Agile with Systems Engineering (Alexander Neng and Eike Appel)
- Successful SE projects by acceptance maximization (Niels Heuthorst)
- Systems Engineering (SE) and Communication in the Digital Age: A New Model for Metacommunication on SE Operations (Freddy Kamdem)
- Rocket Recovery System (Hanspeter Keel and Adrian Senn)
- Frontloading, the evolving challenge in the liquid food packaging industry (Carlo Leardi)

Download the full conference brochure.
Connect with the SSSE LinkedIn group.

Registration for Global Business Analysis Day

The International Institute of Business Analysis (IIBA) has opened registration for its Global Business Analysis Day. This free virtual worldwide event will take place on 1-2 November with separate programs for:

- North & South America (1 November: 10 AM – 7 PM EST)
- Australia (2 November: 10 AM – 3 PM AEDT)
- India, Middle East & North Africa (2 November: 9:30 AM – 1:30 IST)
- Europe & South Africa (2 November: 10 AM – 2 PM GMT)

Topics to be addressed during this round-the-globe round-the-clock event include:

- Starting a Career in Business Analysis
- Hackathon
- Standards
- Product Ownership/CPOA/Agile
- Business Analysis Mindset
- Power Skills Bootcamp
- Cybersecurity
- Rockcrusher
- Being Nimble
- Dealing with cross-cultural communication
- Business Analysis Impact
- Business Architecture
- CoE & Business Analysis
- An Australian Business Analyst's Journey Through Competence and Resilience
- Business Analysis for Better Enterprise Outcomes
- Shaping the Practice of Business Analysis
- New Business Analysis Standard

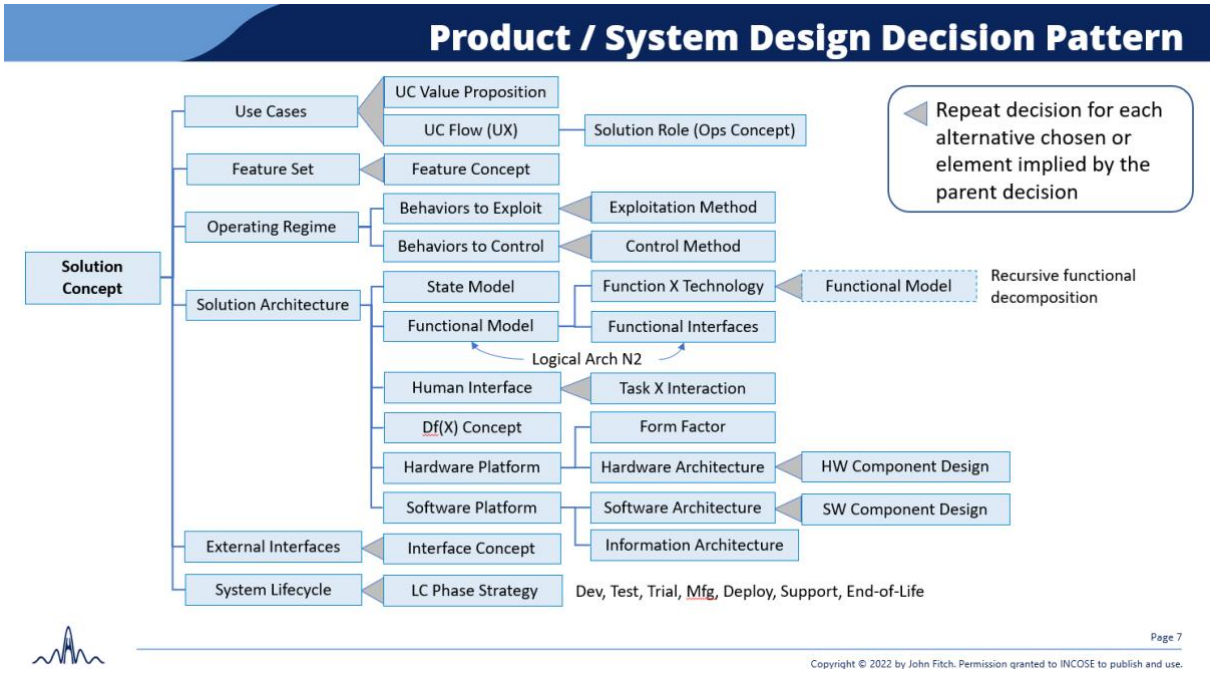
Register here.
Learn more about the IIBA.

INCOSE-GfSE Webinar - Leveraging Decision Patterns

On 28 September, PPI's John Fitch presented a webinar titled "*Leveraging decision patterns to tame complexity and accelerate solution delivery*" as part of the INCOSE/GfSE webinar series. GfSE is INCOSE's German chapter.

Takeaways from this presentation were:

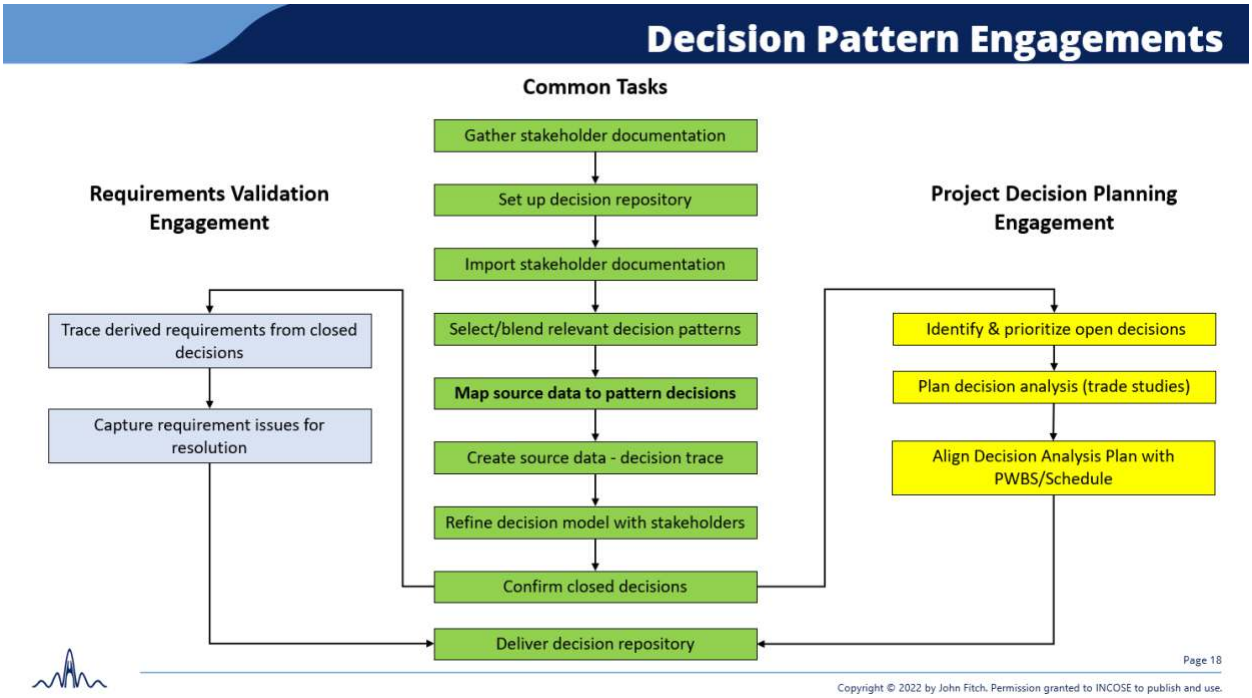
- Decision patterns are a useful technique for managing the complexity and reducing the time-to-capability of engineered systems.
- Decisions are the integrative mechanism of systems engineering and as such decision-to-everything traceability and associated viewpoints should be at the heart of any organization's digital thread.
- Proven decision patterns exist that may be used to quickly frame the scope of any project, validate system requirements, and provide a structure for organizing project work around the most critical choices.
- Although there is limited "native" software tool support for a decision-centric approach to engineering, existing MBSE tools or desktop tools may be extended to deliver this capability.



The presentation summarized key concepts that were shared in previous SyEN articles on decision patterns:

- Introduction to Decision Patterns - SyEN December 2021 Edition
- Decision Patterns – So What? - SyEN April 2022 Edition
- Reverse Engineering Stakeholder Decisions from Their Requirements – SyEN June 2022 Edition

View the Leveraging Decision Patterns video.



Learn more about how PPI's Project Decision Jump-start Services can help you tame complexity and accelerate solution delivery.

"

A goal is a desired characteristic of an item (product or service", usually for which a solution will be pursued, often subject to trade-offs with other goals

Project Performance International

FEATURE ARTICLE

Building a Great "Work" Breakdown Structure

by Robert J. Halligan, FIE Aust, CPEng IntPE(Aus)

Project Performance International

Email: rhalligan@ppi-int.com

Abstract:

The Project Breakdown Structure (PBS), commonly referred to as a Work Breakdown Structure (WBS), if built correctly, is a hugely powerful tool for definition of products and services, costing, scheduling, assignment of responsibility, measuring, reporting, organizational design, and risk management in technical projects. To realize these benefits, the PBS/WBS must be product oriented, i.e., strongly oriented towards the physical structure of the end products to be delivered by the project. Simple, proven sets of rules for building the structure are presented. Available standards and guides on PBS/WBS are overviewed and advice is provided on their use.

1.1 What a WBS Is and Isn't

Let's get one thing straight. A "Work" Breakdown Structure (WBS) isn't a breakdown of work. WBS is a really, really bad name. A "Work" Breakdown Structure is actually a product-oriented breakdown of a *project* into products and services organized in a way that shows how the deliverables of the project are to be created (product) or performed (services) and how other project outcomes are to be achieved.

From here on we are going to call the structure a Project Breakdown Structure (PBS) – not to be confused with a Product Breakdown Structure.

The concept of the PBS as planning document used as a framework for management of a project is well known. The PBS is a hierarchical breakdown which, to be suitable for its intended use, is strongly oriented towards the physical structure of the end products to be delivered by the project. Under product orientation, products and services needed to bring into existence the end and intermediate products are subordinate elements of those products within the PBS

Let's see:

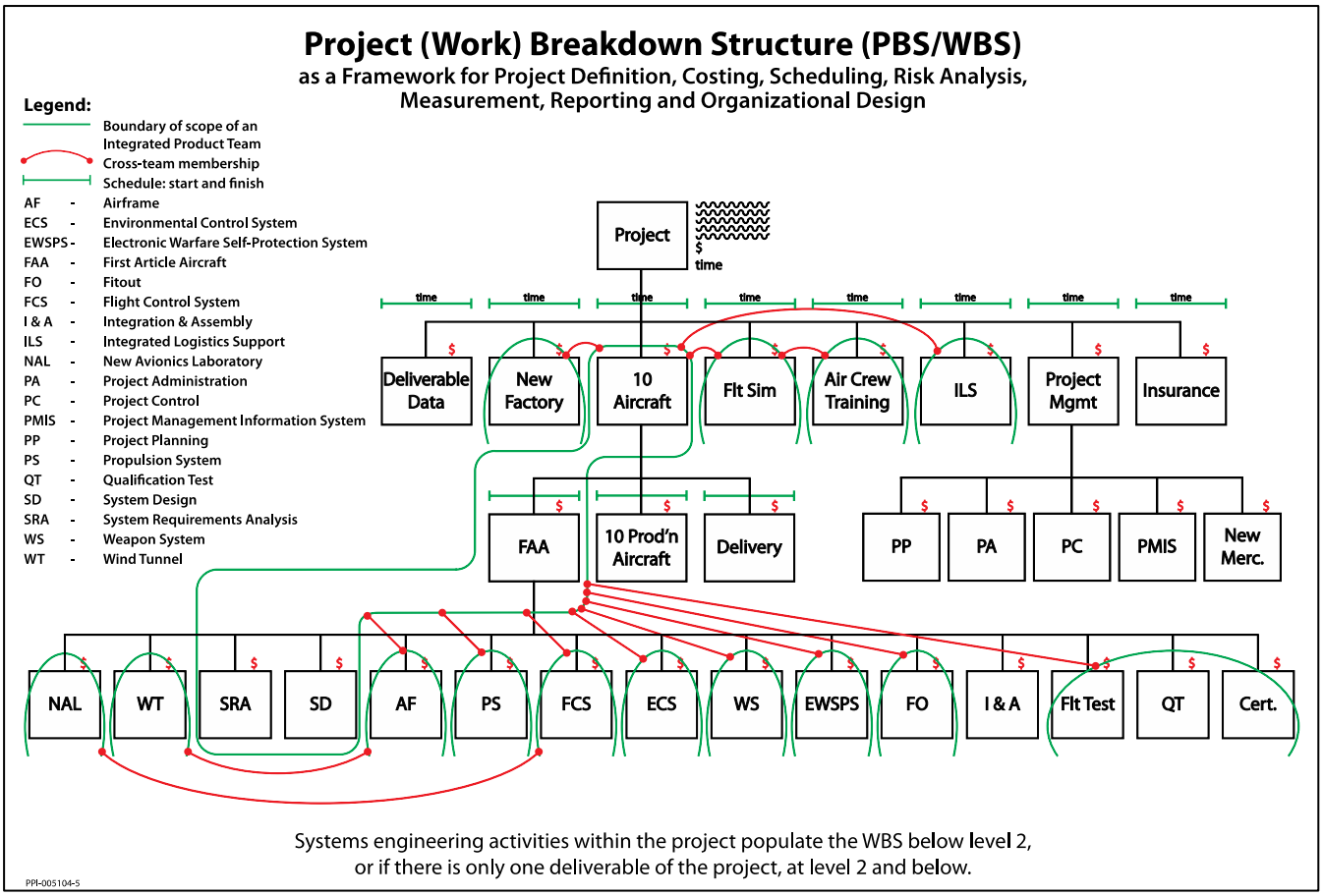


Figure 1.2-1 PBS for a Project to Develop and Supply Aircraft

1.3 Concept and Use of the PBS

The PBS as framework for planning and control of a project has been well known since the PBS was first published by the USA National Aeronautics and Space Administration (NASA) and endorsed by the USA Department of Defense in 1962[1]. The PBS is a hierarchical breakdown that is strongly oriented towards the structure of the end products to be supplied by the project. A bridge is an example of a product. Under product orientation, the products *and the services* needed to bring into existence end and intermediate products are subordinate elements of those products within the PBS. For services to be delivered by the project, the services *and the products* needed to perform the services are subordinate elements of those services within the PBS. Training is an example of a service. To further clarify the distinction between products and services, a *product* is something that is produced, whereas a *service* is an activity that changes some aspect of the state of the universe.

The product orientation of the PBS facilitates its use as a project-wide framework for:

- definition of deliverable products and services;
- definition of products and services internal to the project directly related to the creation of project deliverables;
- project costing and cost management;
- project scheduling and schedule management;
- project risk analysis;
- assignment of responsibility for product creation and service delivery;
- measurement of real accomplishment;
- reporting of accomplishment;
- project organizational design;

- work assignment;
- work authorization;
- identification of stakeholders in subordinate (non-deliverable) elements; and
- contracting and sub-contracting.

The PBS is a hugely powerful tool in planning, assessing the performance of and controlling a project. The PBS is integral to the implementation of Earned Value Management (EVM)-based cost/schedule control systems, technical performance measurement (TPM) systems and integrated project performance measurement (IPPM).

We now turn to examine product orientation in more detail.

2. PRODUCT ORIENTATION

To be product oriented, each element of the PBS should, as a driving principle, include all lower-level products, materials and services required to realize that product or service.

Consider Figure 1.2-1, which shows a product-oriented PBS:

- each set of adjacent elements in a branch of the product-oriented PBS defines the set of contained elements (products and services) that have to be brought together at that level to realize the containing element.
- each set of adjacent elements in a branch of the product-oriented PBS is a logical grouping for schedule planning purposes, since the individual starts and finishes of these elements integrate through dependencies to define the start and finish of the containing element.
- the requirements of the containing element drive the requirements of each contained element. The product-oriented PBS fosters a requirements orientation towards the end result – problem driving solution.
- the product-oriented PBS provides a natural framework around which to design a technical review program; and
- the product-oriented PBS establishes a framework for definition of supplier/customer relationships within the project, including internal supplier/customer relationships.

Although product orientation is very important, departures are appropriate in some circumstances, for example:

- where strict adherence to pure product organization would produce PBS elements that are too small to be cost-effective;
- where work is of a highly interactive nature spanning multiple levels of a product-oriented PBS, for example, project management;
- where the project is long and phased in nature, with each phase having well-defined deliverables, in which case an orientation at level 2 (the level immediately below the project) towards phases, which tend to be functional in character, may be preferable; and
- where projects involve tasks performed repetitively, and very little integration is required between the outputs of those tasks to form the end product, for example, detailing a fleet of 500 cars.

3. BUILDING A GREAT PBS

3.1 For a Project With Two Or More Products and/or Services as Deliverables

This is the usual case. The level 1 element is the project, defined by required deliverables together with constraints such as cost and schedule. The PBS is built by answering a sequence of questions, as follows:

To define level 2 elements:

1. What products (physical/software/data) are required to be delivered by the project?
2. What services are required to be delivered by the project?

   What services are necessary, internal to the project, to deliver the project outputs and outcomes, that are not needed uniquely to create (for physical/software/data product) or deliver (for a service) just a single element from questions 1 and 2?

   One answer to this question 3. is always "Project Management"
3. What products, if any, internal to the project, that involve project cost or other resources in their realization, are necessary to deliver the project outputs and outcomes, that are not needed uniquely to create (for a physical/software/data product) or deliver (for a service) just a single element from questions 1, 2 and 3?

To define sub-elements below level 2, the questions for a product element are:

5-1. What products are to be integrated to create this product element?

5-2. In addition to the products from question 5-1, what services are to be performed to create this product element, that are not needed uniquely to create just a single sub-element from question 5-1?

5-3. In addition to the products and services from questions 5-1 and 5-2 respectively, what products are necessary, that involve project cost or other resources in their realization, to create this product element, that are not needed uniquely to create (for physical/software/data product) or perform (for a service) just a single sub-element from questions 5-1 and 5-2 respectively?

To define sub-elements below level 2, the questions for a service element are:

6-1. What services are to be integrated to perform this service element?

6-2. In addition to the services from question 6-1, what products are necessary to perform this service element, that involve project cost or other resources in their realization, and that are not needed uniquely to perform just a single service sub-element from question 6-1.

3.2 For a Project With Just One Product as the Deliverable

Example project: the bicycle project in the PMI Practice Standard for Work Breakdown Structures, Second Edition [2], or an enterprise-level system.

The level 1 element is the project, defined by the required deliverable product together with constraints such as cost and schedule. The PBS is built by answering a sequence of questions, as follows:

To define level 2 elements:

1. What products are to be integrated to create this sole deliverable product?
2. In addition to the products from question 1, what services are to be performed to create the sole deliverable product, that are not needed uniquely to create just a single element from question 1?

3. In addition to the products and services from questions 1 and 2 respectively, what products are necessary, that involve project cost or other resources in their realization, to create the sole deliverable product, that are not needed uniquely to create (for physical/software/data product) or perform (for a service) just a single element from questions 1 and 2 respectively?

To define sub-elements below level 2, the questions for a product element are:

4-1. What products are to be integrated to create this product element?

4-2. In addition to the products from question 4-1, what services are to be performed to create this product element, that are not needed uniquely to create just a single sub-element from question 4-1?

4-3. In addition to the products and services from questions 4-1 and 4-2 respectively, what products are necessary, that involve project cost or other resources in their realization, to create this product element, that are not needed uniquely to create (for physical/software/data product) or perform (for a service) just a single sub-element from questions 4-1 and 4-2 respectively?

To define sub-elements below level 2, the questions for a service element are:

5-1. What services are to be integrated to perform this service element?

5-2. In addition to the services from question 5-1, what products are necessary to perform this service element, that involve project cost or other resources in their realization, and that are not needed uniquely to perform just a single service sub-element from question 5-1?

3.3 For a Project With Just One Service as the Deliverable

The level 1 element is the project, defined by the required deliverable service together with constraints such as cost and schedule. The PBS is built by answering a sequence of questions, as follows:

To define level 2 elements:

4. What services are to be integrated to deliver this sole deliverable service?
5. In addition to the services from question 1, what products are necessary, that involve project cost or other resources in their realization, to perform this sole deliverable service, that are not needed uniquely to perform just a single service element from question 1?

To define sub-elements below level 2, the questions for a product element are:

3-1. What products are to be integrated to create this product element?

3-2. In addition to the products from question 3-1, what services are to be performed to create this product element, that are not needed uniquely to create just a single sub-element from question 3-1?

3-3. In addition to the products and services from questions 3-1 and 3-2 respectively, what products are necessary, that involve project cost or other resources in their realization, to create this product element, that are not needed uniquely to create (for physical/software/data product) or perform (for a service) just a single sub-element from questions 3-1 and 3-2 respectively?

To define sub-elements below level 2, the questions for a service element are:

4-1. What services are to be integrated to perform this service element?

4-2. In addition to the services from question 4-1, what products are necessary to perform this service element, that involve project cost or other resources in their realization, and that are not needed uniquely to perform just a single service sub-element from question 4-1?

3.4. PBS Development Checklists

A PBS checklist can help ensure that a PBS is sound. Consider the following:

1) Is the PBS product-oriented, i.e., focused on deliverable products and services and their constituent products and services (not a functional or organizational focus)
2) Does the overall PBS include 100% of the project scope of work? This should include enabling services such as project management, requirements analysis, design, system integration, verification and validation, placed correctly in relation to the products or services to which they contribute
3) Does the PBS Dictionary (see below) provide sufficiently complete and explicit content descriptions?
4) Does the PBS extend sufficiently downwards to provide for effective risk analysis, resource planning, management insight, and performance measurement?
5) Do the PBS elements correlate with the following:
   a. Project deliverables
   b. Product Breakdown Structure(s)
   c. Product Specification Tree (s)
   d. Technical scope of work
   e. Overall network scheduling
   f. Intended organizational structure
   g. Any contracting that is intended.
6) Has any necessary evolution of the PBS been planned?

4. COMPONENTS OF A PBS

The PBS comprises:

- a PBS index, which is a family tree graphic or indented list organized as described in 3. using the names of the elements in the structure; and
- a PBS dictionary, which describes at a level of detail suitable for management purposes the scope of each PBS element, such that the aggregation of scopes in the PBS dictionary encapsulates the planning with respect to all products to be realized and all work to be performed in the conduct of the project. The PBS dictionary does not specify in full the products or the work tasks – the dictionary is only as detailed as is necessary to allow the unambiguous association of every hour of labor and every dollar of expenditure to a corresponding PBS element.

  Figure 4-1 shows Figure 4-1 an example PBS dictionary entry.

WBS Dictionary

WBS Element Title: Control CSCI 1	**WBS Element No:** 123456.08.05.09.01.03
Parent WBS No: 123456.08.05.09.01 **Parent WBS Title:** Prototype Radar	**WBS Level:** 6 **Scope Def. Ref:** 02.01.01
Project: Project Mermaid Development	**Originator:** Samuel L Grates

WBS Element Description:

The scope of this element includes the development of all necessary software code required to satisfy the functional requirements established for prototype software. This effort will include the identification of all prototype use-case functions, code development for all identified use-case functions, informal use-case testing, integration of all use-case code and software preparation for full prototype user testing.

Technical Specification Document:

SPEC-SW-AA000765-1

SPEC-SW-AB000767-2

Procurement Packages: None

Related Work Excluded:

1) Associated supervision
2) Prototype requirements validation
3) PP&C planning and control effort

Requirements Doc. No:

SRD-BR549-01

WBS Index: See pages 16-18

Revision No: 01c **Revision Date:** 11/30/2019	**Page** 15 **of** 31 **WBS Element No:** 123456.08.05.09.01.03

PPI-008164-1

Figure 4-1 An example entry in a PBS dictionary.

5. TIMING OF DEVELOPMENT OF PBS

A project that involves little innovation may be amenable to development of the complete and final PBS as a part of initial project planning. Conversely, a project containing many unknowns will necessarily have the PBS evolve to its full level of detail over the planning and design phase(s) of the project. The PBS should be formally adopted only to the level at which it is relatively mature. This level may not be uniform across the PBS.

Some of the benefits afforded by a PBS may be brought forward by evolutionary decomposition of an element into subordinate elements, where subordinate elements are added as they become known, drawn down from a “catch-all” element such as “Other Aircraft Subsystems”.

Since the PBS serves as the framework for project cost and schedule estimation and planning, a popular technique is to differentiate in the PBS between those elements that have been approved for project control and those that exist with provisional status for planning purposes.

6. CORRESPONDENCE WITH DEVELOPMENT

The PBS and the technical program should at all times be in correspondence. If this correspondence is not maintained:

- control over cost, schedule and quality will be weakened or lost;
- additional stages of, and specifications for, system integration may be needed; and
- the technical program may not produce deliverables that correspond to milestone events, or payment or sell-off criteria where contracts are involved.

The PBS should reflect the solution decisions of the technical program, and not the reverse – many a project has failed because of an unsuitable, sometimes arbitrary PBS structure, or a template structure below Level 2 mandated by a customer or by company management. This practice is close to suicidal!

7. CORRESPONDENCE WITH PROJECT/CONTRACT DELIVERABLES

The PBS, in its product orientation, should align precisely with the deliverables defined for the project, and then extend those deliverables downwards via subordinate elements in the structure.

8. OVERVIEW OF WBS STANDARDS AND GUIDES

8.1 MIL-STD-881 Work Breakdown Structure

In the view of the author, the early versions of MIL-STD-881[2] of the United States Department of Defense were a disaster, creating a standard framework for counting the cost overruns caused by imposing a standard framework. A similar assessment applies to MIL-HDBK-881[3]. The most serious problem was in the definition of eight types of system, with a standard template WBS imposed for each. The consequence was that each system matching a particular category had to be engineered to have the architecture directed in the WBS for that category of system, or alternatively:

a. the organization developing a system for the US Department of Defense had to keep “two sets of books”, inefficient to the point of being debilitating; or

b. the developing organization muddled on without a suitable framework for managing the development, with predictable consequences.

This author describes MIL-STD-881 as the standard that has probably done more damage to the human race than any other standard in the history of mankind.

The current edition of this standard, MIL-STD-881E[4], has much-improved guidance but still carries the baggage of template WBSs, albeit with encouragement to depart from the templates when it is advantageous to do so.

8.2 PMI Practice Standard for Work Breakdown Structures

The Project Management Institute (PMI) Practice Standard for Work Breakdown Structures, First Edition[5], was greeted with much condemnation upon release because of its interpretation of WBS as a breakdown of work. To the credit of PMI, the organization responded with rapid development and release of a much-improved second edition[6].

The second edition, still current, describes well the concepts and principles of WBS, still accommodating the “breakdown of work” interpretation but emphasizing the product-oriented strategy throughout the standard. Unfortunately, much of the potential value of the standard is lost in its use as an example of a project delivering a single physical product, a bicycle, rather that the more

common case of multiple deliverable products and services. The bicycle problem is compounded by the example WBS departing from the sound principles advocated in the text.

We cannot here reproduce the PMI bicycle project WBS, but we can provide for comparison a much-improved alternative as Figure 8.2-1.

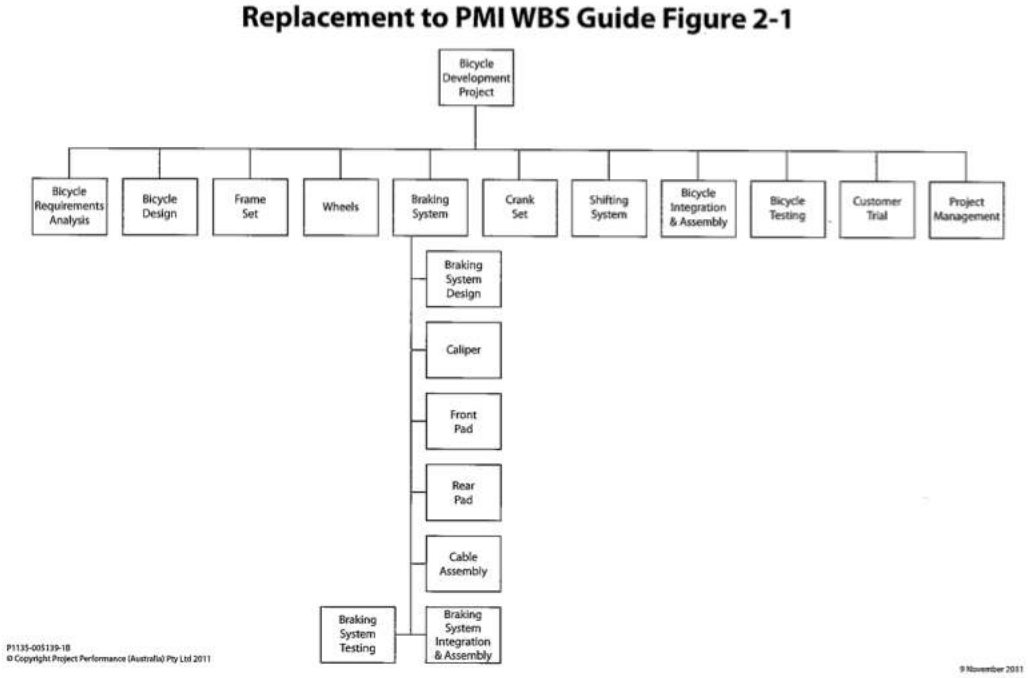


Figure 8.2-1 Replacement Bicycle Project PBS/WBS

The content problem with the second edition of the PMI publication is magnified by a set of examples in the Annexes which, without exception, depart to varying degrees from sound principles.

8.3 DEF (AUST) 5664A Work Breakdown Structures

DEF (AUST) 5664A, Work *Breakdown Structures for Defence Materiel Projects*[7], published by the Department of Defence, Australia is a recommended reference notwithstanding its narrow application focus.

8.4 NASA Work Breakdown Structure (WBS) Handbook

NASA/SP-2010-3404, *NASA Work Breakdown Structure (WBS) Handbook*, 2010[8] contains possibly more useable information on PBS/WBS than any of the other references mentioned in this article, but it must be used with considerable care.

Firstly, the Handbook actively discourages the placement of the services involved in creating a product such as product design, product integration, and product test, as subordinate WBS elements alongside subsystems of the product. In doing so, the roles of the PBS/WBS in supporting definition, costing, scheduling, measurement, reporting, and risk analysis are seriously compromised. As a simple example, the cost of a product is no longer the sum of the costs of its subordinate elements. This is a devastating flaw in the Handbook.

Secondly, the Handbook neglects the origin of definition of subsystems as being in sound design engineering. WBS element names in examples are repeatedly technology classifications rather than meaningful names of subsystems destined to be engineered as configuration items. The link between design engineering and population of the PBS/WBS in the Handbook is tenuous at best. The most serious example of this flaw is the promotion on page 21 of a means of defining subordinate product elements that fails to reflect sound design principles.

9. CONCLUSION

The Project Breakdown Structure (PBS), commonly referred to as a Work Breakdown Structure (WBS), if built correctly, is a hugely powerful tool for definition of products and services, costing, scheduling, assignment of responsibility, measuring, reporting, organizational design and risk management in technical projects.

To realize these benefits, the PBS/WBS must be product oriented, i.e., strongly oriented towards the physical structure of the end products to be delivered by the project. Under product orientation, the services needed to bring into existence end and intermediate products must be an integral part of the structure.

Simple, proven sets of rules for building the structure have been presented for projects with multiple deliverables, a single product deliverable and a single service deliverable.

Available standards and guides on WBS have been overviewed. Whilst the standards and guides provide much potentially useful information, many pitfalls in their use exist and considerable care is needed.

References:

[1] DOD and NASA Guide, PERT/COST System Design, June 1962

[2] MIL-STD-881B, Work Breakdown Structures for Defense Materiel Items, 25 March 1993

[3] MIL-HDBK-881A, Department of Defense Handbook, Work Breakdown Structures for Defense Materiel Items

[4] MIL-STD-881E, Work Breakdown Structures for Defense Materiel Items, 9 April 2018

[5] PMI 978-1-933890-13-5, “Practice Standard for Work Breakdown Structures”

[6] ISBN 1933890134, PMI Practice Standard for Work Breakdown Structures, Second Edition

[7] DEF(AUST) 5664 Issue A, Work Breakdown Structures for Defence Materiel Projects

[8] NASA/SP-2010-3404, NASA Work Breakdown Structure (WBS) Handbook

About the Author

Robert Halligan (FIE Aust CPEng IntPE(Aus)) is an executive project manager, engineering manager and engineering practitioner, known internationally for his role in the practice and improvement of technology-based projects.

Within early engineering, engineering management and project management roles with Telecom Australia, Department of Defence (Australia), Rockwell International and Andrew Corporation, Robert worked extensively in Australia, the United States and the United Kingdom. Over the last thirty years, Robert has contributed to major systems projects worldwide (so far 41 countries) as a consultant and trainer.

The passion that Robert brings to systems engineering, and how to translate it into enterprise improvement, has benefited countless organizations worldwide: private, government and academic. Robert has experience in almost every definable business sector, over a broad spectrum of technologies. Read his full biography here: Robert Halligan Biography.

SYSTEMS ENGINEERING RESOURCES

Useful artifacts to improve your SE effectiveness

System Dynamics Society Mentorship Programs

The System Dynamics Society (SDS) offers a wide range of mentoring options through which interested parties can learn System Dynamics skills with the side-by-side help of proven system modeling experts in the context of real-life projects. Over 25 mentors participate in these programs to help build the skills of next generation modelers.

Peer Mentoring

Peer mentoring groups are student-focused, typically consisting of students who join early in their academic career and continue together until all members have completed their education. Groups are organized around a common interest and geographic proximity. These groups meet regularly to share their work with a typical commitment of 1-1.5 hour sessions every 1-3 weeks, often with summer breaks. A group leader emerges whose responsibility will be to organize the meetings and the agenda, ideally on a regular basis with advance notice. The peer mentoring groups may elect to receive support from an experienced mentor whose role will be to listen in, ask questions, and provide insight and suggestions for the members' work.

View a Peer Mentoring group overview.
Request Peer Mentoring.

One-on-One Mentoring (SDS members only)

Society members received mentoring as a membership benefit through the generous donation of time by experienced practitioners in the field. The mentor meets with a mentee at predetermined intervals to discuss their work and provide technical and process advice. This service is intended for a person who desires regular coaching to build a causal map or System Dynamics simulation model. Mentoring may cover any or all of the stages of modeling (problem definition, model formulation, model testing) and possibly also advice on writing and presentations. The typical commitment is one hour-long meeting per week with some preparation required in between by both mentor and mentee. Mentees should have taken a class or read a book and be ready for the next step: building their own map or model.

Request a one-on-one mentor.

Short-Term Modeling Assistance (SDS members only)

The popular Modeling Assistance Workshop (MAW) has been offered continuously as an event for conference attendees since 2001. The SDS now offers this type of assistance year-round in addition to the conference. Society members can obtain one-on-one coaching on specific System Dynamics modeling questions or obtain guidance on whether SD is an appropriate method to approach a certain problem. Questions may relate to a System Dynamics model that you are thinking about, studying, or developing. All levels of modeling background are welcome, from beginner to advanced. Modeling questions may cover problem articulation, dynamic hypothesis, model formulation, model testing, or policy design and evaluation.

Request Short-Term Modeling Assistance.

Publishing Assistance Workshop (Conference Registration Required)
The Publishing Assistance Workshop (PAW) provides prospective authors with guidance on developing manuscripts using systems thinking and modeling for submission to top academic journals. A panel of System Dynamics experts with impressive publication records share their suggestions for navigating the journal publishing process.

Attend this event at the annual SDS conference if you are interested in publishing your System Dynamics work in academic journals. The first half of this workshop is open to all conference attendees and includes short presentations by a subset of the panel members with tips about publishing System Dynamics research in top journals. The panel presentations will be followed by an open Q&A session.

The second half of the workshop involves small roundtable discussions, exclusive to participants that submit working papers and receive invitations to the second half. This portion of the workshop provides invited participants with developmental suggestions for improving their working papers.

Sign up for PAW.

Learn more about SDS Mentorship programs.

Join the System Dynamics Society here to take advantage of the One-on-One Mentoring and Short-Term Modeling Assistance programs.

Informal help for questions concerning System Dynamics may also be available on the SD Facebook Discussion Group.

PDMA kHUB New and Most Popular Article and Podcasts

kHUB PDMA Knowledge Hub

The Product Development Management Association (PDMA) continues to expand its Knowledge Hub (kHUB), a diverse repository of resources to assist the product development and innovation community. kHUB is the centralized digital content management and access platform for the extensive PDMA Body of Knowledge. kHUB facilitates the creation and exchange of product management, development, and innovation knowledge and best practices to provide the basis for individual professional development and organizational innovation, leading to a competitive edge.

The kHUB editorial board is responsible for content aggregation, curation, and creation for the key areas such as Strategy, Portfolio Management, Product Innovation Process, Product Design & Development Tools, Market Research in Product Innovation, Culture, Teams & Leadership, and Product Innovation Management.

PDMA periodically highlights the most popular articles and podcasts based on kHUB user preferences. New or most-read articles in August and September include:

- Integrated Product Portfolio and Project Management: The Art of New Product Demand Planning
- Serial Innovators: How Individuals Create and Deliver Breakthrough Innovations in Mature Firms
- A Framework for Understanding Emerging Consumer Needs
- Find Pearls and Drive More Innovation in Your Portfolio
- Steve Jobs: A Product Developer's Perspective
- Aligning Product Portfolios with Strategic Plans

- Four Steps to Product Management Excellence for B2B Companies
- 10 Ways to Reduce the Cost of Prototyping**
- Customer-Focused Innovation**

** *Member login required*

Recommended podcasts, videos and external blogs include:

- Innovation+ Talks series (Paul Heller of Sopheon)
- The Product Experience (Lily Smith and Randy Silver from Mind the Product)
- The Rocketship (for entrepreneurs, product managers and anyone working in tech)
- Product Discovery Group blog
- Product Design & Development Tools TEDTalks with Practitioner Insights
- Product Health – A Critical Item for Product Managers to Actively Manage

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

- A Time to Consider, a Time to Deliver: The Independent and Interactive Effects of Regulatory Mode on Innovative Work Behavior
- Supply Chain Innovation: Conceptualization, Instrument Development, and Influence on Supply Chain Performance
- When Cultures Collide: What Can We Learn From Frictions in the Implementation of Design Thinking?

Access to JPIM content may be obtained by a PDMA membership or through a Wiley subscription. Access to kHUB is free and open to the public. Create a guest account or join PDMA here.

What You Need to Know About Business Analysis Core Concept Model – BACCM™

The International Institute of Business Analysis (IIBA) has developed the Business Analyst Core Concept Model™ (BACCM™) framework to communicate the essence of Business Analysis. The BACCM™ describes a set of ideas - core concepts of the business analysis practice and relationship among these ideas. The BACCM™ simplifies what it means to perform Business Analysis work irrespective of perspective, industry, methodology. Having a good understanding of these six core concepts is a key factor that sets up business analysis professionals to successfully enable change and deliver valuable solutions to stakeholders.

On 15 September, the IIBA hosted a webinar titled "*What You Need to Know About Business Analysis Core Concept Model – BACCM*™ to highlight the features of IIBA's new and interactive version of the BACCM™ Canvas. Oge Nwachukwe, a business transformation enthusiast and owner of Pollard Consults, and Stuart Edeal, Lead Solution Architect for Thrivent Financial shared:

- The Concept of BACCM
- The Elements of the BACCM
- Application of the BACCM
- How to design your own BACCM Canvas

Systems Engineering practitioners from all domains will recognize the relevance of the six core concepts that make up the BACCM™, despite the business process framing of its terminology:

- Context – What are the internal and external factors relevant to the change initiatives?
- Stakeholders – Who are the stakeholders impacted by the change?

- Needs – What is the problem, opportunity or constraint the organization is trying to address?
- Value – What are the expected business outcomes as a result of the change?
- Changes – What elements of the organization are changing or will be impacted by the change?
- Solutions – What solutions are we creating, modifying or delivering?

Watch the video here. Download the slides.
Explore the blog: Skills Every Business Analysis Professional Needs
Join the IIBA to gain to access to the KnowledgeHub and new interactive BACCM™.

Latest Resilience Engineering Association Newsletter

The latest newsletter (Issue #12, September 2022) from the Resilience Engineering Association (REA) addresses the role and support that Resilience Engineering can offer to organizations and frontline teams.

Articles on the organizational contributions of Resilience Engineering include:

- Lessons from Addressing Organisational Resilience
- Increasing the adoption of resilience engineering in healthcare - Overcoming practical and systems challenges
- Supporting frontline worker resilience during storm response
- High Reliability Organising is about how you handle possibilities

This newsletter also features a dedication manuscript to the life and accomplishments of Richard Cook, part of REA's initiative to honor Cook's work and legacy at the 10th Symposium on Resilience Engineering scheduled for 26-30 June 2023 in Sophia Antipolis, France.

Access the REA newsletter.
Learn more abou the REA here.

ANSI Standards Action Weekly

The American National Standards Institute (ANSI) issues a free weekly Standards Action publication that covers current standards development activities in the U.S. and internationally. The publication provides timely, accurate information about current standards development work in which ANSI plays a role. It is designed to facilitate participation in the American National Standards (ANS) development process and other domestic, regional, and international standardization activities advanced by ANSI.

Standards Action announcements and notices include:

- Project Initiation Notifications (PINS) for ANS
- Public comment opportunities for draft standards
- Current work underway at the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and ISO/IEC Joint Technical Committee (JTC) 1, through U.S. Technical Advisory Groups (TAGs)

View the latest issue.

SYSTEMS ENGINEERING IN SOCIETY

Expanding applications of SE across the globe

Diverse Applications for Digital Twins

The Digital Twin Consortium (DTC) hosts frequent webinars that highlight the diverse applications of digital twins to a variety of global societal challenges. Two recent webinars provide insights on such applications and offer lessons learned that may be applied to different domains:

- Vancouver Airport - Building the YVR Digital Twin
- Accelerating Livability, Workability, and Sustainability with Digital Twins

Vancouver Airport - Building the YVR Digital Twin

On 12 October 2022 the Digital Twin Consortium (DTC) hosted a webinar on the use of digital twins to address the operational challenges of a major international airport. Christopher Gilliland and Jason Williams shared insights from the Vancouver Airport Authority (YVR) experiences in applying digital twins across the airport's ecosystem.

Abstract: For most cities, airports represent a vibrant hub of economic activity with opportunities for spurring growth. At the same time, there is the responsibility to maintain the comfort and safety of millions of travelers and airport employees over the course of a year. As with any large business, there are considerations for operational efficiency, climate change, and sustainability – areas where digital twins excel. In this session, you will learn how Vancouver's major international airport is embracing the power of a digital twin.

YVR's IT organization is leveraging twins across all aspects of the airport ecosystem, enabling a complete, real-time view of activities. The twins will not only transform operations but will also help the airport to connect with its community and build new revenue streams.

Attendees learned:

- How state-of-the-art digital twin technology performs to scale in a dynamic, real-time environment.
- Business validation of how twins advance operational efficiency.
- Tips for leveraging twins for environmental sustainability and circularity.

Key points included:

- The airport uses a gaming simulation platform, Unity, as the sandbox in which to create, evaluate and deploy value-added digital twin applications.
- The foundational data for the simulation experience was populated by high resolution (accurate within 3 cm) scans both outside the airport terminal and inside.
- The gaming environment provides a common digital twin user experience across desktops, laptops, tables and smartphones.
- Use cases, although limited by imagination only, are dependent on the availability of and software integrations with real-time data feeds.
- Agile methodologies that incrementally deliver value are well suited to application development in this environment.

There was no discussion on how on-going capital improvement projects at the airport utilize or update the digital twin during their concept development, design and construction phases.

View the video here.

Accelerating Livability, Workability, and Sustainability with Digital Twins
On 19 October 2022 the Digital Twin Consortium (DTC) hosted a webinar on the application of digital twins to smart cities. Philip Bane, Managing Director of the Smart Cities Council, summarized the trends that he has observed over the past decade in application of various technologies to the needs of cities and their constituents.

Abstract: Cities are contending with rapid population growth and dwindling resources. And the risk is rising: there is an increase in climate change-related disasters, exacerbated by poor city planning. To keep pace, we need more food, water, and energy. In fact, on a global scale, according to the Smart Cities Council, we need to build the equivalent of Chicago every month for the next 30 years. This webinar will look at best practices, standards, and techniques for becoming a smart city – which is defined as a city that uses innovation, technology, and data to accelerate livability, workability, and sustainability.

Today's smart cities can reasonably predict and mitigate sustainable and resilient solutions through the use of data analytics. Smart cities are discovering cost-effective solutions with a foundation in AI, ML, simulation, and visualization. Now digital twins are being brought into city planning as a way to mitigate risks and manage resources more effectively.

Philip Bane will look at how to leverage data from sensor networks across buildings and cities. He will also investigate ways to remove blockers to city capacity, procurement, and financing. Key takeaways from this webinar include:

- How to treat city-wide data as an asset
- Key drivers and barriers to adoption of digital twins in cities
- Efficient and effective management of digital twins
- Guidance for building command and control architectures and integrating best-of-breed systems

Additional insights included:

- There is no lack of standards (strategic, process and technical), programs and policies in the smart cities domain. Shortfalls abound in terms of results delivered.
- Despite more than a decade of use, the definition, scope and focus of smart cities are still evolving. In 2012, a smart city was defined as one "using digital technology to improve livability, workability and sustainability". By 2022, that had evolved to "using innovation, technology and data to accelerate livability, workability and sustainability".
- The recent focus on acceleration is the result of too many smart city initiatives suffering "death by pilots".
- Cities must distinguish between three mutually supportive, but different, types of outcomes: Smart, Resilient and Sustainable.
- Dramatic reductions in sensor costs and an increase in sensor platform types (infrastructure, automobiles, buildings, smartphones, etc.) have created an explosion in data volumes, without commensurate ability to support new use cases.

- Building information systems, if integrated, are a source of valuable insights into what is happening between buildings, not just within them. Many use cases may leverage such data.
- Western cities are looking for the integration of multiple "best of breed" solutions, not a centralized, top-down command and control model. In general, data federation creates more value than data centralization.
- Data should be treated as a city-wide asset. Data management policies should emphasize transparency and sharing. Cities and their citizens don't want black box algorithms. Data governance policies must accommodate the privacy concerns of their constituents.
- The effective visualization of data is still a roadblock; most smart city dashboards are awful.
- The technology adoption cycle of a typical city is much longer than in other industrial or consumer domains.
- The most promising digital twin applications are focused on economic development use cases.
- Smart city initiatives should never lead with technology; always lead with needs.

Download Phillip Bane's slides.
View the video here.

Principles for broader application of digital twins
According to the DTC definition: A digital twin is a virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity:

- Digital twin systems transform business by accelerating holistic understanding, optimal decision-making, and effective action.
- Digital twins use real-time and historical data to represent the past and present and simulate predicted futures.
- Digital twins are motivated by outcomes, tailored to use cases, powered by integration, built on data, guided by domain knowledge, and implemented in IT/OT systems

The Digital Twin Consortium's webinar library hosts numerous videos that highlight current trends in DT applications and technology. The diverse range of 30-minute webinars hosted in 2022 include:

- IoT Security Maturity Model Digital Twin Profile
- Reality Capture: A Digital Twin Foundation
- Practical Considerations for Aerospace & Defense Digital Twins
- Digital Twins as Remote Operations Centers (ROCs) for Alternative Energy
- The Role of DT in Performance-Based Simulation to Achieve Decarbonization
- Digital Twins Transform Alternative Energy Production
- Energy Transition Acceleration with Digital Twins
- Digital Twin Transformation for the Built Environment
- Technology Trends for Digital Twins
- The Digital T's -- Threads, Twins, Technology, and Transformation
- Is ISO 23247:2021 a Digital Twin Standard for Manufacturing?
- Building and Managing a Digital Twin in Semiconductor Manufacturing Operation
- Digital Twins Providing Real Value in Manufacturing
- Virtual Worlds with Nvidia Omniverse
- Integration Without Translation, Digital T-Winning

- Digital Twin Capabilities Periodic Table for Composable Digital Twins
- How Digital Twins Accelerate the Energy Transition
- Harnessing the Power of Digital Twins - Spanning Many Markets
- Digital Twins in Healthcare - A Philips Perspective
- Digital Twins in Real Estate: The Chrysler Building
- Harnessing the Power of Digital Twins - Roundtable Discussion
- Harnessing the Power of Digital Twins - Smart Buildings, Smart Cities
- The Role of Digital Twins in Spacecraft Design
- Harnessing the Power of Digital Twins - Energy
- Harnessing the Power of Digital Twins - Supply Chain, Healthcare, Automotive
- Driving Growth and Adoption of Digital Twins - A look inside the DTC

Learn more about the Digital Twin Consortium here.
View DTC membership information.

Reflections on Prof. Bob Cryan's IET Presidential Address 2022

On the 13th October 2022, Bob Cryan, presented his IET President's Address titled 'Engineers- holding the keys to the future of humanity'. A video format of the presentation is available on IET's YouTube channel. This presentation is incredibly inspirational and aspirational for engineers, technicians and those wanting to enter into the field.

Bob Cryan shares his journey to becoming the youngest Professor in the UK including the memorable 'clothing peg story'. In this tale, Bob recalls how he and a group of students were asked to break apart a clothing peg and put it back together for the opportunity to be part of a sought-after mentorship. The students who could put back together the wooden clothing pegs the fastest were invited to be part of the mentorship program. Bob was one of the last students to complete this task did not get into the program. Later, he was pulled aside by one of his professors and told that he was scraping the bottom of the barrel and that he had a slim chance of being successful in engineering.

This failure and the added criticism fueled Bob to put his head down and put in consistent effort, pursuing excellence at every turn during his engineering degree. Over time this resulted in Prof. Cryan achieving the highest accolades and top grades throughout his studies. Prof. Cryan has maintained an avid thirst for learning and continues to accrue more qualifications each year. Prof. Cryan shares the message that failure and rejection can provide the perfect environment for unchartered growth if one uses setbacks as an opportunity to learn and move forward. In describing his journey from clothing pegs to becoming an engineer, Bob recalls the joy that buying a 75-in-1 electrical kit brought him after several months of saving by working two jobs each day while still in high school. A healthy curiosity for figuring out how things work has always been a feature in Bob's character.

One of the most endearing aspects of this video was getting insight into how involved Bob is in almost every layer of the IET. He is very dedicated to tactically expanding the physical and professional architecture of the IET and is very connected with employees throughout the organization. This cross-hierarchical immersion aligns with Bob's positioning that engineers should view themselves as leaders and build up their managerial and leadership skills alongside their technology expertise. Bob views fostering 'engineers as leaders' as one of the three main areas of focus during his 2022-2023 presidential lead of the IET. The second area of focus is inspiring the next generation of engineers with competitions and development programs for young students. His third area of focus is on actively supporting mentorship by connecting dedicated students with professional engineers, providing a mechanism for experienced engineers to share tacit knowledge. This will pave the way for future engineers to upskill themselves and solve societal challenges.

Amongst some of the biggest engineering concerns raised, climate change and especially the fashion industry were pinpointed as key areas where the ingenuity of engineers is needed in order to reverse some of the damage caused to the environment. IET is an organization that is looked to by the public and private sector for guidance and input to solving problems in our society. Joining the IET will provide you access to essential engineering resources and a community of like-minded engineers dedicated to development and helping the planet. Consider joining today!

Read PPI SyEN 116 – September edition, for more information on the background of the IET).

System Dynamics in Education

Recent articles associated with the System Dynamics Society (SDS) have highlighted to potential role of System Dynamics in the educational process. During his presentation at the 2022 International System Dynamics Conference, Ilir Rodiqi tackled the question "*Is System Dynamics the Missing Subject in our Educational System?*" Read more about his affirmative conclusions and examples here.

The SDS provides multiple resources that support their hypothesis that games promote experiential learning about systems.

The Beer Game was developed to introduce students, managers, and executives to System Dynamics concepts, illustrating the key principle that structure produces behavior. Players experience the pressures of playing a role in a complex system and can see long-range effects during the course of the game. Two Bloomberg articles highlight the relevance of the Beer Game to current supply chain and pandemic-related issues:

- MIT's 'Beer Game' Shows Humans Are Weakest Link in Supply Chains
- What MIT's Beer Game Teaches About Panic Hoarding

Buy the Beer Game.
Request a Beer Game facilitator.
View all SDS game products here.

Smart Cities and Communities: A Key Performance Indicators Framework

At the World Cities Summit in Singapore, 31 July through 3 August 2022, Michael Dunaway of the U.S. National Institute of Standards and Technology (NIST), presented the Framework for Key Performance Indicators for Smart Cities and Communities in NIST Special Publication 1900-206. The Framework is a measurement methodology for assessing the direct and indirect benefits of smart city technologies. The methodology enables the integration, adaptability, and extension of three interacting levels of analysis: technologies, infrastructure services, and community benefits. The presentation was part of the Summit's focus on smart cities, sustainable infrastructure, the circular economy, cybersecurity, and digital transformation.

This NIST publication presents research findings and scientific work that advance the development and progression of smart city and community measurement methodology. The term 'smart,' as used in the phrase 'smart cities,' is defined here as the efficient use of digital technologies to provide prioritized services and benefits to meet community goals. Without reliable measurement methods for 'smart,' there is a gap in the ability to answer questions such as 'how smart is my smart city plan,' or 'how can my community strategy be made smarter?' This report addresses this gap by introducing a measurement framework for assessing the direct and indirect benefits of smart city technologies.

The Holistic KPI (H-KPI) Framework builds on conventional Key Performance Indicators (KPI) methods and accounts for unique characteristics such as varying districts and neighborhoods, differences in population and economic scale, the reuse of previously deployed technologies, and other factors relevant to a city or community. The Framework provides the basis for developing measuring methods and tools that allow for integration, adaptability, and extensibility at three interacting levels of analysis – i.e., technologies, infrastructure services, and community benefits. The H-KPI method provides a structured representation of smart city/community information flows that supports system visualization, serves as the basis for quantitative metrics for measuring 'smart,' and enables computational methods for systems design, analysis, operations, and assurance. The five core metrics of the method are:

- Alignment of KPIs with community priorities across districts and neighborhoods
- Investment alignment with community priorities
- Investment efficiency
- Information flow density
- Quality of infrastructure services and community benefits

Applications of the H-KPI approach include strategic planning, systems design and assurance, and operations management.

Download the Framework.

Faculty Positions at Stevens Institute of Technology

The School of Systems and Enterprises (SSE) at Stevens Institute of Technology (Hoboken, New Jersey, USA) invites applications for tenured and tenure-track faculty positions, at the Full, Associate, or Assistant Professor level, starting Fall 2023 or on a mutually agreed upon date. Successful candidates will contribute to a dynamic and growing research and educational program in the areas of engineering management, systems engineering, software engineering, space

systems engineering, industrial engineering, complex systems, cyber physical systems, and underlying enabling technologies, such as machine learning, data engineering, and embedded systems.

Faculty duties include:

- Teaching at the undergraduate and graduate levels
- Advising and mentoring graduate students
- Conducting externally-funded research
- Contributing to service to Stevens and to the professional community.

Candidates will be expected to become leaders in their field of research, to develop a vibrant externally-funded research program, and to contribute to best-in-class educational programs.

Applicants must possess a doctoral degree in a related engineering or science discipline prior to commencement of employment. To apply, please submit your package as a single PDF file that contains your curriculum vita, cover letter, research statement, teaching statement, and contact information for 3 references to sse.search@stevens.edu. Please direct questions to Prof. Onur Asan at oasan@stevens.edu. Review of applications will commence immediately and continue until the position is filled.

Learn more about careers at Stevens here.

Upcoming PPI Live-Online ™ Systems Engineering Five Day Courses

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

P006-897-1	Asia UTC +8:00 (SGT 5:00) PPI Live-Online	07 Nov - 11 Nov 2022
P006-897-2	Oceania UTC +11:00 (AEDT 8:00) PPI Live-Online	07 Nov - 11 Nov 2022
P006-898-1	North America UTC -7:00 (MST 8:00) PPI Live-Online	14 Nov - 18 Nov 2022
P006-898-2	South America UTC -3:00 (BRT 12:00) PPI Live-Online *(Only available in South America)*	14 Nov - 18 Nov 2022
P006-899-1	Europe UTC +1:00 (CET 9:00) PPI Live-Online	05 Dec - 09 Dec 2022
P006-899-2	United Kingdom UTC +0:00 (GMT 8:00) PPI Live-Online	05 Dec - 09 Dec 2022
P006-899-3	South Africa UTC +2:00 (SAST 10:00) PPI Live-Online *(Only available in South Africa)*	05 Dec - 09 Dec 2022
P006-900-1	Asia UTC +8:00 (SGT 5:00) PPI Live-Online	12 Dec - 16 Dec 2022
P006-900-2	Oceania UTC +11:00 (AEDT 8:00) PPI Live-Online	12 Dec - 16 Dec 2022
P006-901-1	North America UTC -5:00 (EST 8:00) PPI Live-Online	19 Dec - 23 Dec 2022
P006-901-2	South America UTC -3:00 (BRT 10:00) PPI Live-Online *(Only available in South America)*	19 Dec - 23 Dec 2022

FINAL THOUGHTS FROM SYENNA

As Syenna is away on holiday this month, in the spirit of her quirkiness, the rest of the PPI SyEN team decided to share with some of our favorite engineering jokes.

The Hunting Trip

An engineer, a statistician, and a physicist are out hunting.

They spot a deer, and each take a turn to try and bag it.

The physicist goes first. He pulls out his lab book and quickly calculates the trajectory of the bullet, assuming it is a perfect sphere in a vacuum. The bullet falls 20m short of the deer.

The engineer goes second. He pulls out his engineers pad and book of projectile assumptions. After a few minutes he's ready, he takes aim, and he fires. The bullet lands 20m passed the deer.

The statistician leaps in the air shouting, "We got it!"

Glass Half Full

To the optimist, the glass is half full.

To the pessimist, the glass is half empty.

To the engineer, the glass is twice as big as it needs to be.

The Wedding

Two antennas got married - the wedding was lousy, but the reception was outstanding.

Wind Turbines

Wind turbine 1: "What kind of music do you like?"

Wind turbine 2: "I'm a big metal fan"

Discover more engineering jokes like this at Entech Technical Solutions