# PPI SyEN

SYSTEMS ENGINEERING NEWSJOURNAL EDITION 113 | JUN 2022

## *Onward to Better Requirements*

**REQUIREMENTS WORKING GROUP**
Expanding the body of knowledge

**REVERSE ENGINEERING DECISIONS**
How to attack a challenge

**PPI SYEN SPOTLIGHT: ADVANCING MBSE**
Interview with Juan Navas and Stéphane Lacrampe

A PROJECT PERFORMANCE INTERNATIONAL PUBLICATION | PPI-INT.COM

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

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

## WELCOME

Welcome to the June edition of PPI SyEN! The theme of this edition is 'Onward to Better Requirements', one of my favorite subject areas within SE. This edition is packed with power, I hope you'll agree!

This month we have two fascinating Feature Articles – one is a detailed summary of the 'Highlights of the INCOSE Requirements Working Group' by Tami Katz and Lou Wheatcraft (The RWG Chair and Co-Chair respectively). The RWG has been hard at work and the results of their dedication are aptly captured in this article. Secondly, we have another outstanding article by John Fitch demonstrating another application of Decision Patterns. This is the third in his series of articles on Decision Patterns written for PPI SyEN. This time, John unpacks how to use a Decision Blitz to 'Reverse Engineer Stakeholder Decisions from Their Requirements'. You don't want to miss either of these articles!

If you want to model your requirements, you may decide to invest in an MBSE software tool to do so! Juan Navas and Stéphane Lacrampe provide thought-provoking responses to questions about the Capella tool, MBSE, digital engineering, and more.

You know it wouldn't be PPI SyEN if we stopped at major articles, in this edition we ask for your input on terms of the zeitgeist such as Digital Thread and Digital Mesh (see PPI SyEN Forum). Page through the edition and read about upcoming conferences, upcoming webinars, and the latest developments in various working groups and SE Chapters around the world. Also find out about updates on the latest software tools and additions to PPI's System Engineering Goldmine.

This edition packs a punch in the SE resources section. Expect to find links access to guides, frameworks, and other resources support you in your daily engineering work. We then close off the edition with some Final Thoughts from Syenna which really shines a light on dimensional blindness!

Here at PPI, we're always eager to hear the thoughts of our readership and to provide opportunities for our readers to share their wisdom and experience by submitting Feature Articles. If you have ideas you would like to share in an upcoming edition, please don't hesitate to contact us via: **PPISyEN@PPI-Int.com**

Thank you for your time and attention in reading this Newsjournal, a lot of effort goes into producing this publication every month. A special thanks to our Editor, John Fitch, the PPI marketing team, and our publishing assistants. Without you, producing this monthly publication would not be possible. See you in July!

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.*

# PPI SyEN FORUM

***Selected correspondence from readers, authors, and contributors***

PPI SyEN FORUM offers the opportunity for feedback and discussion on topics around systems engineering – especially those that have been (or should be) addressed in PPI SyEN.

Please send your email to PPISyEN@ppi-int.com

**Digital Thread, Digital Mesh or Digital Mush?** By John Fitch, Editor, PPI SyEN

I recently attended the excellent Integrate22 conference in San Antonio. If one term summed up the conference it was "Digital Thread". The majority of conference presentations and vendor booths were abuzz with discussion concerning what "it" is, how to create "it" and the benefits flowing therefrom.

In the research for my Integrate22 presentation (guilty as charged), I investigated the term a bit and found it missing from the current (2015) release of the INCOSE SE Handbook V4.0. However, the 2021 INCOSE SE Vision 2035 document uses "digital thread" eleven times but without an explicit definition.

It's no surprise that language evolves, but the sudden explosion in the use of any term always spikes my hype meter. I thought I would put the matter to the collective wisdom of our SyEN readership.

1. When and where did you first read or hear the term "digital thread"?
2. What is the essence of the term, i.e. the reason, in your opinion, why it expresses something new and different enough to justify its displacement of other long-lasting terms?
    - New classes of knowledge being captured?
    - New relationships between knowledge classes?
    - New phases of the systems lifecycle being incorporated?
    - New visualizations of connected knowledge?
    - A step function increase in the density of relationships?
    - New rule-based analytics enabled to improve engineering quality and efficiency?
    - Other?
3. What is the best definition for "digital thread" that you have found?
4. On a scale of 0 – 10 (where 0 = ultimate marketing hype and 10 = extreme value created), where does "digital thread" fall?

I look forward to your feedback and insights! John

**FEEDBACK**

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

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

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

**Tell us about it, at PPISyEN@ppi-int.com**

# SYSTEMS ENGINEERING NEWS

*Recent events and updates in the field of systems engineering*

**Call for Papers: Open Journal for Systems Engineering (OJSE) – SE4AI/AI4SE**

The Institute for Electrical and Electronic Engineers (IEEE) Open Journal for Systems Engineering (OJSE) has issued its second Call for Papers for a special issue seeking original papers that address the challenges in realizing Systems Engineering for Artificial Intelligence (SE4AI) and Artificial Intelligence for Systems Engineering (AI4SE). Potential topics include:

| | |
|---|---|
| Adversarial machine learning | Hybrid human/AI systems |
| AI resilience | Life-cycle ready AI |
| AI risk analysis | Model curation |
| AI-enabled evidence building | Multi-modal AI |
| AI/SE workforce development | Security in AI |
| Anticipatory design | Systems approaches to AI architecting |
| Automated model-building and simulation | Systems theory and AI |
| Automation of digital twins | Test & evaluation of learning-based systems |
| Cognitive bias in AI systems | Trustworthy AI |

OJSE is an Open Access journal for which authors pay the publication costs. For 2023, publication costs are projected to be $975 (USD) for a 10-page manuscript. See details concerning paper submission here.

The deadline for manuscript submission is 1 September 2022. Final manuscripts are due on 15 February 2023. Submit papers here.

See additional details on OJSE here.

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**SESA Announces New President**

The Systems Engineering Society of Australia (SESA) has announced that Jawahar Bhalla (JB) will transition from Technical Director and acting President to SESA President on 1 July 2022. Bhalla is a passionate Systems professional with 30+ years' experience established across multi-national organizations in technical and strategic leadership roles delivering complex capabilities across sectors. He continues to contribute to the understanding and advancement of Systems Thinking, Systems Engineering and Modelling & Simulation locally, regionally, and globally, through leadership roles in organizations including SESA and Simulation Australasia. He was recognised in 2021 as the recipient of the Simulation Australasia Ray Page Lifetime Achievement Award for making an outstanding contribution to the advancement of Modelling and Simulation in the Australasian region.

Bhalla has a BE in Aerospace Engineering and a BSc in Computer Science from UNSW, and a Master's in Systems Engineering from UNSW@ADFA. He is a current iPhD candidate on an Australian Government Research Training Program Scholarship at the University of Adelaide.

Learn more about SESA. See the full announcement.

## INCOSE SySTEM Initiative becomes SySTEAM

SAN DIEGO (31 May 2022) – The International Council on Systems Engineering (INCOSE) created the SySTEAM (Systems, Science, Technology, Engineering, Arts, and Mathematics) initiative, with a vision to improve the quality of STEAM education worldwide, for all students, by changing the way in which educators, administrators, and other relevant stakeholders place value on and leverage Systems Thinking/Systems Engineerng (ST/SE) skills, and by establishing a community to advocate for holistic integration of ST and SE principles and skills into existing STEAM curricula and programs.

Our vision is for a world where every student will be equipped with the interdisciplinary skills they need in order to succeed in today's globalized society. With the heartfelt conviction that the arts and humanities are a critical part of that interdisciplinary vision, we want to recognize the contributions those fields can offer systems engineering and systems engineering competency education and vice versa.

Putting the 'A' in SySTEAM is a way for us to tell our community and the rest of the world that we see the arts and humanities as being just as important as the sciences, and that we've embraced that perspective in our efforts.

The SySTEAM community is made up of volunteers from around the world, and is open to new members from all professions, experience levels, and nationalities, regardless of INCOSE membership status.

See full INCOSE press release here.
For additional information about SySTEAM, visit incose.org/systeam.
Join the SySTEAM community here.

## INCOSE Chapter and Working Group Highlights

As a global professional society, much of the business of INCOSE is conducted "in the trenches" through the work of regional chapters and topic-focused working groups (WGs).

Highlights of recent chapter activities include:

- In May, five INCOSE chapters in Europe (Italy, Belgium, Spain, Switzerland and France) conducted a series of INCOSE events in a virtual and hybrid mode, collectively known as the Southern European Systems Enginering (SESE) Tour 2022. The event theme was "Systems Engineering for a Sustainable World".

- The INCOSE UK Chapter is preparing for its ASEC 2022 conference in November. View more news from INCOSE UK in their ePreview newsletter.
- The India Chapter hosted its second annual MBSE Summit in May with 18 hours of educational sessions.
- The Japan Council on Systems Engineering (JCOSE) conducted two virtual workshops. The first summarized results from IW2022. The second was a talk and panel discussion concerning system safety (e.g., ISO 21488).
- The Singapore Chapter hosted a talk by Dr. Lui Pao Chuen concerning the state of systems engineering in Singapore and emerging SE trends.
- Members of the recently-formed New Zealand Chapter are actively engaged in addressing the systems engineering challenges associated with the Auckland City Rail Link (CRL) and next-generation reusable medium-lift launch vehicle (Neutron) projects.
- INCOSE Brasil is celebrating its 10th anniversary as a chapter and recalls its members' contributions to multiple aerospace solutions over the decade.
- The Colorado Front Range (CFR) Chapter promoted systems engineering to STEM students, industry and political representatives at the Colorado Aerospace Day in March. Preparations are underway for the Western States Regional Conference to be hosted by CFR on 30 September – 2 October.
- In May, the Chicagoland Chapter hosted more than 45 engineers in a tutorial on Lifecycle Concepts and Needs Definition, presented by Lou Wheatcraft.
- The Texas Gulf Coast Chapter hosted an MBSE Tool tutorial from Dassault Systemes and also participated in the Offshore Technology Conference.
- The Washington Metropolitan Area (WMA) Chapter has a established a Collaboration Joint Working Group with its Project Management Institute (PMI) counterpart in the Washington, DC, USA area to enhance the understanding of project management and systems engineering across both organizations.

Recent working group highlights include:

- The Artificial Intelligence Working Group (AI WG) kicked off its AI Explore Series, bi-monthly interactive talks to explore & educate in key issues regarding Artificial Intelligence (AI).
- The SE Principles Working Group, led by Michael D. Watson, Ph.D. of NASA, has been makng final preparations for release the Systems Engineering Principles Publication, in conjunction with IS2022.
- The Digital Engineering Information Exchange (DEIX) Working Group continues its support of transforming systems engineering to a model based discipline by on-going efforts of its Standards Framework (SF) and Digital Viewpoint Model (DVM) teams. The SF team is forming an ISO working group to define standards for digital engineering concepts and vocabularies.
- The Configuration Management Working Group has written an article, Providing Truth, Trust, and Traceability to Modeling, that addresses top-level concepts on how to model trust within system models.
- The newly-formed Systems Engineering and Lawmaking (SELAW) Working Group invites INCOSE members to join them as they explore the application of systems engineering to the design and validation of laws.
- The Training Working Group welcomes the new cochair, Stephen Wolf, of Northrop Grumman and thanks Gabriela Coe for her contributions to the WG.

PPI SyEN encourages our readers to connect with these chapters and working groups to contribute your expertise to their efforts to advance the field of systems engineering.

## New Definitions in PPI's Systems Engineering Goldmine


PPI continues to add new content to the Systems Engineering Goldmine (SEG), which already comprises over 4 GB of resources. The SEG menu, shown to the left, illustrates the rich range of information available.

The SEG contains over 7800 definitions of terms related to the discipline of systems engineering. A specialized Definitions Search option is available from the SEG top-level menu. Multiple definitions may be provided for any search term. Definitions include their source and acronyms (where applicable). In many cases, PPI has supplied a more generalized definition of a term than those stated in other sources, e.g. domain-focused international standards or national governmental agencies.

Here are some definitions that have been updated or added to the SEG in the last quarter and that illustrate the range of topics addressed in this unique resource.

*Allocatable function*
A solution-level sub-function that can be, and is to be, performed by a single element in the system breakdown structure at the physical level one level below the system-of-interest. (Source: PPI)

*Architecture framework*
An architecture framework is an encapsulation of a minimum set of viewpoints that describe a system's architecture. A viewpoint defines the set of information providing a particular view of interest to a stakeholder. A view is a partial expression of the system architecture, from a particular perspective. For a given architecture framework, architecture is fully defined by the set of views, each from a particular viewpoint. (Source: Mitre Corporation)

*Basic research*
Long-range, non-focussed inquiry that advances the state-of the-art frontiers of fundamental knowledge. Basic research may never have a practical application and is directed toward solving the axiomatic problems of nature. (Source: PPI)

*Configuration Item*
A Configuration Item (CI) is an item (any item), a set of characteristics of which is baselined (a reference set established at a point in time), and against which change is subsequently controlled (proposed, proposal approved, executed, and execution approved, all with corresponding records). (Source: PPI)

*Criterion-driven integration*
System Integration where the elements that are most influential in relation to a selected criterion are integrated first, for example, overall risk, some measure of performance, reliability. Each selected criterion is generally related to risk, at least indirectly. (Source: PPI)

*Design traceability*
Traceability from requirements and goals to information that explains how the requirements and goals are met in the design. (Source: PPI)

*Engineering Specialty Integration*
Engineering Specialty Integration (ESI) is: "The effective integration of non-technology disciplines such as reliability, maintainability, supportability, human factors, safety, value engineering, standardization, transportability, etc., such as to ensure their beneficial influence on requirements, design and ultimately, the product".

*Maintainability*
A characteristic of design and installation which determines the probability that a failed equipment, machine, or system can be restored to its normal operable state within a given timeframe, using the prescribed practices and procedures. (Source: www.businessdictionary.com)
The ability of a system to be maintained. (Source: INCOSE Systems Engineering Handbook, 4th edition)

*Qualification*
That which qualifies; any natural endowment, or any acquirement, which fits a person for a place, office, or employment, or which enables him to sustain any character with success; an enabling quality or circumstance; requisite capacity or possession". (Source: Webster)
A pass of an examination or an official completion of a course, especially one conferring status as a recognized practitioner of a profession or activity. (Source: Oxford English Dictionary)
In an engineering management context, the act deeming something to be approved for a particular purpose. (Source: PPI)

*Spiral development*
A stage-based, stage-gate, risk and opportunity-driven approach to system development that prioritises effort towards resolving the greatest areas of greatest risk and/or opportunity in order of diminishing concern. (Source: PPI)

*System breakdown structure*
A System Breakdown Structure is a hierarchical representation for the system of the first physical level of solution elements for that system, whether or not those solution elements are themselves engineered. (Source: PPI)

*System dynamics*
System dynamics (SD) is an approach based on systems thinking to model for understanding of the nonlinear behaviour of complex systems over time using stocks, flows, internal feedback loops, and time delays. (Source: PPI)

*System of Interest*
A System of Interest (SoI) is a system that is the subject or focus of the engineering. (Source: PPI)

*Technical Performance Measurement*
Technical Performance Measurement (TPM) involves the selection of key measures of engineering accomplishment, the planning of a profile of accomplishment for each TPM Parameter for the duration of development, the measurement of actual accomplishment, the comparison of actual to plan, the reporting of variances and trends, and the extrapolation of current actual to an Estimate At Completion (EAC), the EAC being compared with requirements and goals. (Source: unknown)

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.

**Intercax Syndeia 3.4 Released**

Syndeia™, first released in 2014 by Intercax, is 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. The platform provides services for building, managing, analyzing, querying, and visualizing the Digital Thread of a system or product.

Supported tools and repositories include:

- SysML modeling tools (e.g. MagicDraw, Rhapsody)
- PLM systems (e.g.Teamcenter, Windchill)
- CAD systems (e.g. NX, Creo)
- ALM systems (e.g. GitHub, JIRA)
- Project Management Systems (e.g. JIRA)
- Requirements Management Systems (e.g. Jama, DOORS-NG)
- Simulation tools (e.g. Mathematica and MATLAB/Simulink)
- Databases (e.g. MySQL)
- other data sources (e.g. Excel).

Syndeia leverages a variety of open standards (e.g. REST/HTTP, JDBC, JSON, STEP, OSLC, and FMI), open source projects and libraries, and production-ready APIs.

Syndeia version 3.4:

- Made the repository integrations (e.g., JIRA, Jama, etc.) available via the Syndeia Web Dashboard and the Syndeia Cloud REST API.
- Introduced a new Digital Thread Explorer™ to visualize and navigate artifacts and relationships within and across repositories.
- Enabled creation of relationships between the models/data across repositories.
- Enhanced the query, analysis and reporting capabilities of the Syndeia Cloud REST API.
- Introduced six new integrations: Aras Innovator, Bitbucket, Confluence, GitLab, Teamwork Cloud, and SysML v2 API.

Syndeia's latest release, version 3.4 Service Pack 2 includes the following enhancements:

- Removal of log4j from Syndeia clients
- Support for MagicDraw 2021x Refresh 2 Hotfix 1 and later versions
- Improved error handling and logging with Creo session
- Improved error handling with Windchill part usages and occurrence
- Improvements in Syndeia installation scripts

See more details on Syndeia 3.4 SP2 here.
Download Syndeia.

# CONFERENCES, MEETINGS & WEBINARS

## 2022 International System Dynamics Conference is Imminent


The International System Dynamics Conference (ISDC) is an annual event where people from all over the world interested in the practice of System Dynamics and systems thinking gather. Now in its 40th year, the Conference appeals to audiences across industry and academia. The conference introduces newcomers to the field, keeps practitioners aware of current developments, and provides a wide range of networking opportunities.The 2022 International System Dynamics Conference (ISDC2022) will be held on 18-22 July, both in Frankfurt, Germany and online. Both modes of participation will provide access to the full conference program.

Featured plenary sessions include:

- *The Dynamics of Privilege (John Sterman):* Most people attribute their successes to their personal capabilities and actions. Actions and outcomes are easily observed, but your success also depends on the systems in which you are embedded, including your race/ethnicity/gender, and your family, community, school, and other circumstances.
- *From Limits to* Growth *to Earth for All (Jørgen Randers):* Humanity is now midway in the "overshoot and collapse" mode described in The Limits to Growth 50 years ago – we have serious climate overshoot, but not yet global collapse. How will human well-being develop during the evolving encounter with planetary limits?
- *Co-creating Energy Solutions (Merla Kubli):* This presentation invites you on a journey to different forms of co-creation in the energy field. In the effort of fighting climate change, new energy solutions emerge that disrupt the roles of consumers and producers.
- Tipping the Scales - Using Microworlds to Uncover Systemic Issues Driving Organization's Gender Pay Gap (Hugo Jose Herrera de Leon): In this plenary, we'll summarise our experience using microworlds (system dynamics interactive environments) to facilitate conversations about the structural issues driving the gender pay gap at an organizational level. It is the summary of three years of conducting workshops with senior leaders of private and public sector entities.
- Renewable Energy Sources - Diversity of Impacts, Perspectives, and Challenges - (Santiago Arango Aramburo): Renewable energy sources are cornerstones to tackling the climate crisis and a fundamental part of the energy transition. Investment costs have significantly declined in the last decades which, together with economic incentives, has led to rapid growth in renewable capacity.
- *Learning Economics with Dynamic Modeling - Collaboration of Norway and Ukraine (David Wheat & Team):* Struggling to develop a System Dynamics university program and community? Professors at UiB, NaUKMA and LNU present how collaboration led to building capacity in System Dynamics skills and providing practical assistance to government ministries, the central bank, and schools in Ukraine.

- *Gender Segregation Dynamics - Women's Participation and Performance in Competitive Chess in the Netherlands (Jeroen Struben):* Equality and diversity within society are vital for social justice and contribute to societal progress and organizational and economic performance. Yet, gender and other inequality persist throughout societies, appearing in different forms and configurations. To analyze the dynamics of persistent gendered segregation, this work leverages the empirical context of competitive chess.
- *Can Interactive Simulation Impact What Policymakers Say and Do on Climate? (Juliette Rooney-Varga):* In the US and elsewhere, policies to mitigate climate change remain vastly inadequate. While political and public discourse on climate change and its potential solutions has intensified in recent years, the topic remains contentious. Learn how the En-ROADS simulator is helping decision-makers create better climate policies.
- *Overcoming Capability Traps in State Development (Paulo Gonçalves):* As countries seek to develop, the administrative capability of governments to implement policies and programs that shape their growth and impact is critical. We'll discuss conditions that cause states to get stuck in capability traps and possible ways to escape or avoid them.

ISDC2022 is organized by topical threads, including:

- *Business and Strategy:* Features applications of System Dynamics in businesses and organizations including strategy development, profitability, marketing, competitive dynamics, product launches, project dynamics, and accounting.
- *Diversity (NEW):* Features applications of System Dynamics on topics such as gender, race or ethnicity, class, age and ability, etc.; racial justice work that addresses issues including, but not limited to, structural racism, interpersonal discrimination, or institutional bias; and submissions that demonstrate diverse experiences with System Dynamics.
- *Economics:* Features papers improving understanding of economic dynamics including macroeconomics, microeconomics, trade, business regulation, economic development, economic policy, insurance, and risk management.
- *Health*: Applies System Dynamics to issues related to health and health care including health policy, health services research, population health, and physiology.
- *Learning and Teaching*: The manner in which system skills are taught and learned including pedagogy, learning experiments, curriculum development, workshop design, and interactive activities designed to be part of an educational experience.
- *Methodology*: Welcomes contributions to System Dynamics modeling and simulation including quantitative *and* qualitative aspects of model development, model analysis, validation, graphical *presentation* formats, computational techniques, and integration of System Dynamics with other approaches such as Artificial Intelligence and Predictive Analytics, among others.
- *Operations*: Includes business and other process operations including capacity management, quality *control*, operations management, supply chains, workflow, queuing, and workforce planning.
- *Psychology and Human Behavior*: Explores the dynamics within and between social groups, including *social* environments or individual psychological factors, and spanning families, organizations, and societies.
- *Public Policy*: Covers issues including governance, social welfare, equity, justice, political science, urban *dynamics*, and infrastructure.
- *Security, Stability, and Resilience*: Investigates issues related to security, stability, and resilience, *including* defense, social and international conflict, military operations, insurgency, *counterinsurgency*, cybersecurity, disinformation, safety, disaster management, peace engineering, justice, (financial and economic) crime, policing, incarceration, socioeconomic inequality, and food-energy-water security.

- *Stakeholder Engagement*: Emphasizes engaging and influencing stakeholders through participatory activities such as group model building, facilitation, facilitated modeling, games and management flight simulators, with emphasis on assessing the impact of the engagement.
- *Transport and* Mobility *(NEW)*: Covers all aspects of transportation systems and mobility, including transport and urban planning policies; new services, technologies or business models; decarbonization and sustainable mobility; transport and health; and freight and logistics.

Register here. View conference schedule. Onsite attendees will find directions, accommodations and COVID/visa guidelines here.

System Dynamics Society members enjoy an additional conference discount. Join here.

### SESA Systems Engineering Test and Evaluation (SETE) Conference 2022

The Systems Engineering Society of Australia (SESA) is hosting a Systems Engineering Test and Evaluation (SETE) Conference on 11-14 September 2022. This hybrid event will be held conjunction with the Australian Systems Engineering Workshop (ASEW). The Southern Cross Chapter of the International Test and Evaluation Association (ITEA) co-sponsors SETE.

The conference theme is "*enabling resilience through disruption*". Topics include:

- Resilient systems: Critical infrastructure, resilience and sovereignty, sovereign industry capabilities, system integration and interconnectivity, technical accountability and governance.
- Methodology advances: Agile approaches, model-based approaches, systems methodologies and frameworks, experimentation, test and evaluation.
- Digital innovation: Big data, data analytics, machine learning and Artificial Intelligence, Digital Twins, cyber capability, information assurance.
- Human and social factors: Ethical design, human capability and competency, human-systems integration, social disruption and wellbeing.

Early bird registration is open through 18 July.

See conference details. Join SESA.

### Webinar: Multisolving - Working With Complexity and Interconnection


According to Elizabeth Swain, founder of the recently-launched Multisolving Institute, multisolving occurs when people work together across sectors to address multiple problems with one policy or investment. Multisolving may be applied to diverse societal challenges such as climate change, biodiversity loss, inequity and global health crises.

The System Dynamics Society (SDS) will host a webinar by Swain on 31 August that will share bright spots of multisolving from around the world. The webinar will also explore the obstacles to multisolving, and how systems thinking and systems tools can help people overcome these obstacles.

*About the speaker:*

Elizabeth Swain, a biologist with a Ph.D. from the Massachusetts Institute of Technology, is an expert on solutions that address climate change while also improving health, well-being, equity, and economic vitality. She developed the idea of 'multisolving' to help people see and create the conditions for such win-win-win solutions. Beth writes and speaks about multisolving, climate change, and leadership in complex systems for both national and international audiences. Her work has been published widely, including in Non-Profit Quarterly, The Stanford Social Innovation Review, U. S. News, The Daily Climate, and System Dynamics Review.

Register for the webinar here. It is free for SDS members, else a nominal fee.

Check out additional resources from the Multisolving Institute:

- Training and tools.
- Upcoming events.
- Articles, case studies, press & videos.
- Blog.

**PDMA Webinars in July**

The Product Development Management Association (PDMA) will host two webinars in July aimed at improving the business results associated with new product development.

On 12 July, the PDMA St. Louis (Missouri, USA) chapter will host *Release isn't Launch*. Steve Johnson, a product success coach with Product Growth Leaders, will discuss how to align the rhythms of internal teams with industry events to create impactful product releases. Attendees will learn how to define responsibilities and tasks for effective product release and launch.

Specific learning objectives include:

- Learn to use kanban for launch planning.
- Prioritize launch tasks with IDEA.
- Create a one-page canvas with key launch information.
- Explain the difference between field testing and product preview.

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

A 21 July PDMA webcast will feature Gocious' CTO and Co-founder, Maziar Adl, posing the question, "*How Effective is Your Product Strategy at Delivering Business Results?*". Adl will address how to determine if a product strategy is aligned with business objectives and customer needs.

Attendees will learn how:

- A business can drive greater busines goals by clearly seeing the bigger picture of long-term plans.
- To enable teams to deliver on the company vision
- To build a strategic plan using a financial baseline
- To align product strategy with business goals

- To enable teams to collaborate more effectively.

This is a free event for PDMA members with a nomimal charge for non-members. Learn more. Register here.

## INCOSE Webinar - Assessing Team Excellence

The INCOSE San Diego (California, USA) chapter hosted a webinar, *Assessing Team Excellence*, on 25 May. The presentation by Ryan Price, Product Lead for the Command & Control Processor (CP2) program at Naval Information Warfare Center (NIWC) Pacific, focused on the goals and objectives of the team excellence assessment.

The motivation for the assessment was the realization that collaborative, well-functioning self-managed teams are the key to successful delivery of capabilities at NIWC Pacific. Key assessment areas, derived from Google's Project Aristotle included:

- Psychological Safety
- Dependability
- Structure & Clarity
- Meaning
- Impact

Participants answered five questions in each area.Including pilot deliveries, NIWC has conducted over 100 team excellence assessments to date. Key presentation points included:

- Developing and defining requirements of the assessment
- Team Excellence core values as built into the assessment
- Results to date
- Lessons learned and challenges
- The Team Excellence Assessment path forward

View the webinar here.

FEATURED ARTICLE

# Highlights of the INCOSE Requirements Working Group (RWG)

*by Tami Katz, RWG Chair and Lou Wheatcraft, RWG Co-Chair*



News and happenings from the Requirements Working Group!

**About the INCOSE RWG**

*Purpose*

The purpose of the Requirements Working Group (RWG) is to advance the practices, education, and theory of needs and requirements development and management and the relationship of needs and requirements to other systems engineering process activities.

*Goal*

Expand and promote the body of knowledge of needs and requirements and its benefits within the systems engineering community.

*Scope*

Activities relating to best practices for needs and requirements development and management throughout the product lifecycle including:

- Elicitation
- Analysis
- Allocation & budgeting
- Expression
- Elaboration
- Management
- Traceability
- Verification
- Validation

**RWG is About…**

- Understanding how to improve the practice of systems engineering through excellence in needs and requirements development and management across the lifecycle.
- Learning from experiences and sharing with the SE community.
- Questioning approaches that yield poor outcomes.
- Developing and making available products that communicate guidance and best practices concerning needs and requirements development and management, verification and validation.

The RWG is comprised of members from industry and academia with a common purpose of improving the practice of systems engineering through improvement of needs and requirements development and management across the system lifecycle.

**RWG Leadership**

- Chair: Tami Katz; Ball Aerospace, USA
- Co-Chair: Lou Wheatcraft; Wheatland Consulting, USA
- Co-Chair: Mike Ryan; Capability Associates Pty Ltd, AU
- Co-Chair: Raymond Wolfgang; Sandia National Lab, USA

**RWG at IW2022**

It has been a busy time for us in the RWG. The year started out with our activities centered around the INCOSE International Workshop (IW2022).

We held virtual sessions prior to IW2022 which were supported by some amazing speakers! The set of topics are highlighted below, and you are welcome to check out the recordings at our INCOSE RWG YouTube Channel RWG IW2022 Sessions - YouTube (please Subscribe to get notifications of new material).

- "Ontologies as a Cornerstone to Merge Knowledge from Models and Documents" by Ilyes Yousfi (ReUse Company)
- "Introduction to EARS (Easy Approach to Requirements Syntax)" by Alistair "Mav" Mavin
- "The Digital Thread - Enabler of Automated Requirement Quality Assessment" by Henrik Mattfolk
- "Requirements and Verification Management Using SharePoint Tools" by Tony Williams
- Panel discussion on "Today's tools gaps, upcoming tools gaps, and new capabilities that vendors should be paying attention to? (discussion)" by speakers from Jama Software, Zuken and Vitech
- "How to Be Successful in the Absence of Requirements" by Ron Carson
- "Needs, Requirements, Verification and Validation Lifecycle Manual Overview" by Lou Wheatcraft

During IW2022, RWG Chair Tami Katz and Co-Chair Lou Wheatcraft hosted a discussion at the Hybrid IW2022 to provide highlights of our busy 2021 and focus for 2022, and we appreciated the support of those that were able to attend (the picture to the right shows Tami in the room with participants, both in person and the Zoom monitor of the virtual attendees).

**Verification and Validation in Context**

One of the most iconic figures that the RWG has developed and matured over the last several years is the Verification and Validation in Context (Figure 1 below).

This figure has been downloaded many times, printed out in poster forms, and placed on bulletin boards and walls within organizations resulting in endless discussions. A major concept communicated in the figure is that needs, requirements, verification, and validation are common threads that tie all systems engineering process activities together across the lifecycle. In this figure, system of interest (SOI) could be an integrated system/product, a subsystem, or a system element.

The figure applies to each realized SOI, no matter where in the integrated architecture the SOI is. Through a series of transformations across the SOI lifecycle, the systems engineering technical process activities transform systems engineering input artifacts into output artifacts that are inputs into other technical process activities, which in-turn transform those artifacts into additional artifacts.

This series of transformations results in a SOI that address the capabilities needed by the stakeholders.

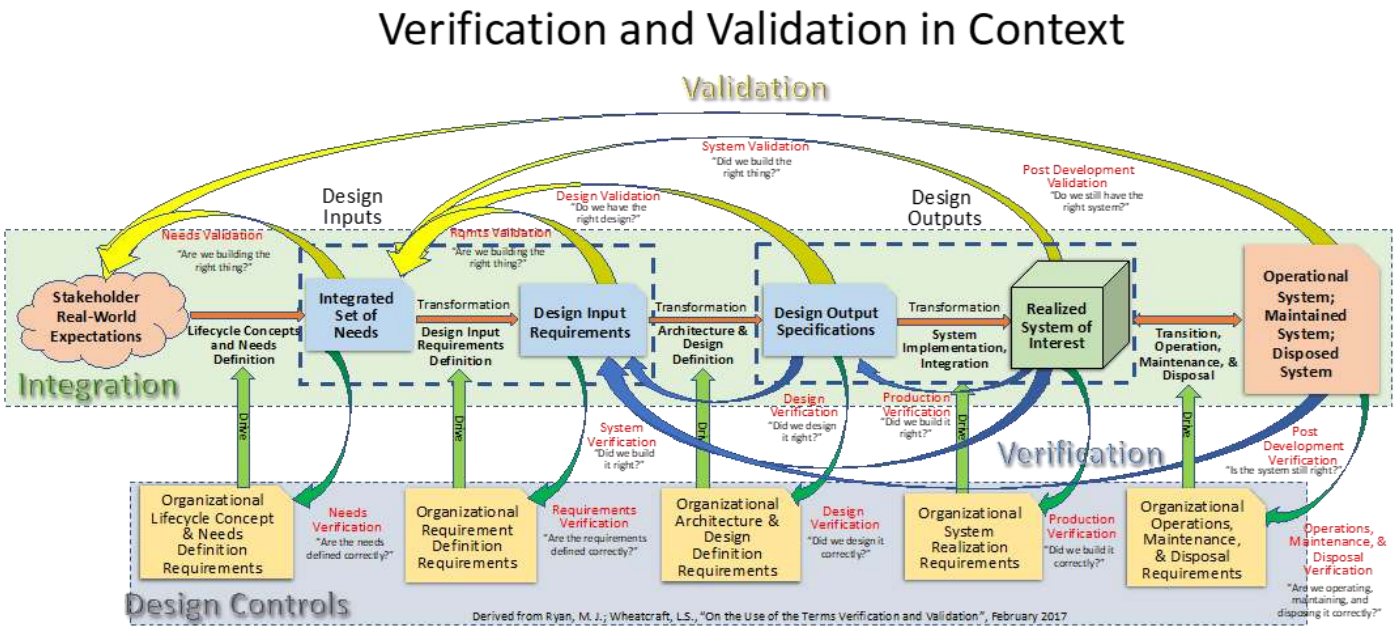


*Figure 1: Verification and Validation in Context*

It is important to understand several key points when viewing this figure.

- Each of the transformations are verified to have been performed by the project team in accordance with the process activity requirements defined by a set of design controls established by the organization.
- While the figure depicts the series of transformations in a linear fashion, in practice the technical process activities are intended to be practiced concurrently, iteratively, and recursively as the project team moves down the layers of the system architecture and moves across the system lifecycle.
- System Integration begins starting at the beginning of the project and continues across the lifecycle. In doing so, the project team takes a holistic view of the integrated system, continuously addressing interactions of the parts that make up the integrated system as well as interactions with the macro system of which it is a part. In addition, the project team is assessing the behavior of the integrated system as a function of these interactions and looking for emerging behaviors and properties – both good and bad.
- Following each transformation, the output artifacts are verified against the design input requirements to ensure the output artifacts' transformation was 'right' as defined by their requirements.
- Following each transformation, the output artifacts are validated against the integrated set of stakeholder needs to ensure the output artifacts are the 'right' artifacts as defined by the integrated set of stakeholder needs.
- The integrated set of needs is validated against the stakeholder real-world expectations to ensure the integrated set of needs accurately communicates the intent of the stakeholders real-world expectations.
- Once the SOI has successfully completed system verification, system validation, and production verification, has been integrated into the system it is a part, it is deployed and entered operations by its intended users in its operational environment. While deployed, post-deployment validation is performed to help ensure the SOI remains the right SOI that meets the

stakeholder real-world expectations – is the SOI still the right SOI? In addition, post-deployment verification is performed to help ensure the SOI is still meeting its design input requirements over time – is it still 'right'?

Further elaboration of these key points is addressed in the products developed by the RWG.

**RWG Products**

Over the last several years, the RWG has been working on new products and supporting development of other INCOSE publications. A major effort is our contributions to the update to version 5 of the *INCOSE Systems Engineering Handbook (SE HB)* that is planned to be available in 2023.

Another major effort was the development of new products and updating existing products. Figure 2 shows our products and their relationship to each other and how they align with the INCOSE Systems Engineering Handbook and SEBok. We are pleased that these new products also support the INCOSE Corporate Advisory Board (CAB) needs as it is our aim to provide value to the future practice of System Engineering in support of industry, the academic community, and INCOSE's newly released *SE Vision 2035 – Engineering Solutions for a Better World*.

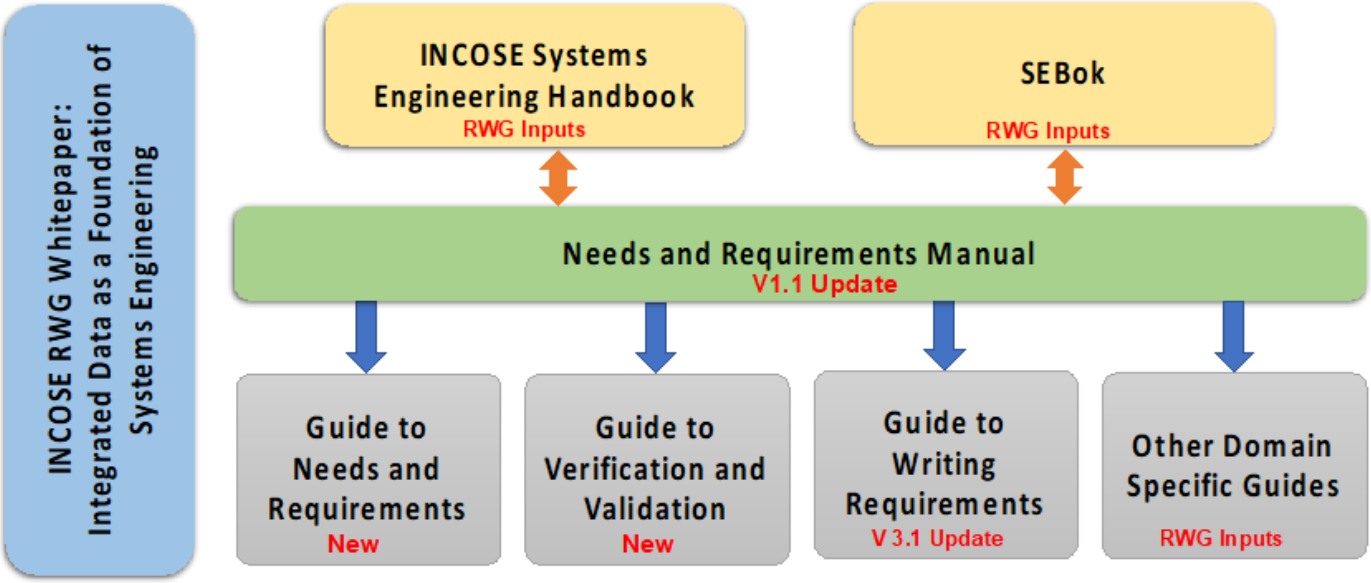


*Figure 2: RWG Work Products and Relationships*

The first of our new products, *Needs, Requirements, Verification and Validation Lifecycle Manual (NRVVLM)*, was first released in the INCOSE Store just prior to IW2022. An update to this manual with a shorter title, *Needs and Requirements Manual (NRM) v1.1* was released the end of May 2022.

Our other new products, the *Guide to Needs and Requirements (GtNR)* and *the Guide to Verification and Validation (GtVV)* are now complete. These Guides will help the user with application of the concepts and activities discussed in the NRM, giving guidance on practical application, examples, and checklists. This fits into our larger portfolio of working group products, which provide a rich body of knowledge for all things dealing with needs and requirements! As part of our product development activities, we have ensured that all our products are in alignment. As part of the alignment effort, we updated the *Guide to Writing Requirements (GtWR)* and the *GtWR Summary Sheet* to version 3.1. All our new and updated products are now available in the INCOSE Store, free for INCOSE members and a nominal charge for non-members.

We appreciate any feedback to our products so that we can continue to improve them with future updates.

### RWG Events

The RWG holds regular RWG Exchange Cafes and also hosts guest speakers. We alternate between the RWG Exchange Cafes and guest speaker presentations. A preliminary schedule between now and IW2023 is shown below.

- June 25 – 30: IS2022 - We are holding an RWG Session at IS2022 for Tuesday, June 28 in the afternoon 1:30-2:55 pm EST.
- July 20: Presentation by Beth Wilson on Systems of Systems (SoS) challenges.
- August 24, 3 pm: RWG Exchange Café – Beth Wilson lead on SoS vs the NRM, GtNR, GtVV
- September 28: RWG Exchange Café – General discission focusing on interfaces
- October 26: Presentation by Beth Wilson – System Security Challenges
- November 16: RWG Exchange Café – Beth Wilson lead on System Security vs NRM, GtNR, GtVV
- December 14: Presentation by Henrik Mattfolk – "Configuration Management Across the Digital Thread"
- January 2023: IW 2023 RWG prevent sessions - TBD

Notifications of our monthly meetings is via the RWG member mailing list, LinkedIn, Twitter, and the INCOSE Teams and Yammer sites. Both INCOSE members and non-members alike are welcome to attend and participate in our monthly meetings as well as view recordings of our meetings via the INCOSE RWG YouTube channel.

### Biographies

Dr. Tami Katz is a Staff Consultant at Ball Aerospace working as a chief engineer on various space mission projects. She holds Bachelor and Master degrees in Aerospace Engineering, and a Doctorate of Philosophy in Systems Engineering and was recently certified as an International Council on Systems Engineering (INCOSE) Expert Systems Engineering Professional (ESEP).

Dr. Katz is located in Colorado, where she is serves as the chair of the INCOSE Requirements Working Group and frequently supports Systems Engineering Department at the Colorado State University as a guest speaker.

Dr. Katz has been involved in the development of space vehicles and space components for over thirty years for Hughes Space and Communications, Boeing Space Systems, Sierra Nevada Corporation, and Ball Aerospace. During her career, she has extensively worked in systems and test engineering of space vehicles, performing a range of activities from design, requirements development, verification, validation, test, and technical leadership. Over the last several years, Dr. Katz has performed extensive research into techniques towards optimizing the requirements management process, publishing multiple papers and a Ph.D. dissertation.

Lou Wheatcraft is a senior consultant and managing member of Wheatland Consulting, LLC. Lou is an expert in systems engineering with a focus on needs and requirements development, management, verification, & validation. Lou provides consulting and mentoring services to clients on the importance of well-formed needs & requirements helping them implement needs & requirement development and management processes, reviewing and providing comments on their needs and requirements, and helping clients write well-formed needs & requirements.

Lou has over 50 years' experience in systems engineering, including 22 years in the United States Air Force. Lou has taught over 200 requirement seminars over the last 21 years.

Lou supports clients from all industries involved in developing and managing systems and products including aerospace, defense, medical devices, consumer goods, transportation, and energy.

Lou has spoken at Project Management Institute (PMI) chapter meetings and INCOSE conferences and chapter meetings.

Lou has published and presented many papers concerning needs and requirement for NASA's PM Challenge, INCOSE, INCOSE INSIGHT Magazine, and Crosstalk Magazine. Lou is a member of INCOSE, past Chair and current Co-Chair of the INCOSE Requirements Working Group (RWG), a member of the Project Management Institute (PMI), the Software Engineering Institute (SEI), the World Futures Society, and the National Honor Society of Pi Alpha Alpha.

Lou has a BS degree in Electrical Engineering from Oklahoma State University; an MA degree in Computer Information Systems; an MS degree in Environmental Management; and has completed the course work for an MS degree in Studies of the Future from the University of Houston – Clear Lake.

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# Reverse Engineering Stakeholder Decisions from Their Requirements

*by John Fitch*

*Project Performance International*



Authored for PPI SyEN

**Introduction**

When faced with a new set of needs or requirements in any form from a customer or set of stakeholders, how do you begin to attack that challenge? For the last 30 years of my career, the answer has been simple. Conduct a Decision Blitz to reverse engineer my stakeholders' decisions from the requirements they have given me. [1, 2] Put that decision model in front of the stakeholders to validate those decisions, refining them as needed and identifying "open" decisions for which the stakeholders don't have a chosen alternative/course of action (or don't agree upon one). Update the system requirements (with stakeholder concurrence) by explicitly tracing the system requirements from the decisions that the stakeholders agree are "closed". Define the boundary of the development project in terms of the open decisions for which I or my team are responsible to deliver a solution.

I have done this process 100+ times across my career, found it to be an extremely efficient and effective way to gain understanding of my stakeholders' problem and to kick start the use of more detailed and rigorous requirements analysis and modeling techniques. The method also jump starts the framing of the project's essential thinking as a Decision Breakdown Structure (DBS) which can be used to guide, accelerate, and align the results of the solution design process.

Of course, this simple process isn't trivially simple or repeatable without some new skills. I learned it from the ground up. It's based on a set of decision patterns that I have been actively refining across my entire career and are therefore "in my head". It's engine is a non-traditional view of requirements derivation and traceability.[3] Few fit-for-purpose software tools exist to facilitate the process.

My goal in this article is to deliver "How to" guidance on using a decision reverse engineering method as a requirements analysis and validation tool. It may be helpful for you to first read (or re-read) two prior SyEN articles on decision patterns:

- Introduction to Decision Patterns (SyEN edition #107, December 2021)
- Decision Patterns – So What? (SyEN edition #111, April 2022)

My hope for this article is that you will be sufficiently intrigued by the potential payoff of this requirements analysis and validation technique to take first steps toward mastery of this method and application of this approach to your development projects.

**Where do requirements come from?**

The simple answer – your stakeholders' decisions. If you do a thought experiment concerning any requirement in any specification that you have ever seen, you can likely identify where an "upstream" decision by your stakeholders concerning the role of the System of Interest (SoI) in their larger world would invalidate or significantly alter the requirement.

I have not found an exception to this rule, even when offering this challenge to hundreds of students in various systems engineering courses that I have taught. If you have such an example, please email me and I will be happy to identify the requirement-invalidating or requirement-altering decision that you have overlooked.

Even if the "decisions create requirements" principle is universally true, it begs the question, "Is this principle useful?" My answer is a resounding "Yes!". 100 percent traceability between stakeholder decisions and system requirements is possible and certainly such traceability has significant value in validating system requirements. Is 100 percent traceability essential? No – as with all engineering process investments, it's likely that traceability from decisions to the most demanding, mission-critical, architecture-driving and design-constraining requirements will have the highest payoff in the form of eliminating the requirements gaps/defects that produce loss of value to your stakeholders.

**Step 1: Reverse Engineer Stakeholder Decisions**

Decisions are the integrative thought process in any strategy or design effort. As such, they are thirsty information-sucking beasts that demand both problem and solution domain knowledge from the stakeholders, innovators and evaluators in any such project. This knowledge pull is amplified when you can put a proven decision pattern in front of stakeholders in a visual format and use the pattern as a questioning framework to probe for the "givens". While many MBSE artifacts repel the uninitiated because of their visual complexity and notational fine points, a decision pattern may be communicated as a simple table or tree diagram.

But prior to sharing the pattern with stakeholders, it is most efficient to take what they have already written and use such documentary sources to begin the reverse engineering process. As the first step in conducting a Decision Blitz, reverse engineering gives the analyst the opportunity to become immersed in the originating requirements, isolate solutions within these requirements and map these solutions to decisions in the pattern. A skilled practitioner can create a 50-decision model of the situation in a few days of effort, typically from 20-50 pages of stakeholder documentation.

After receipt of stakeholder source information, the Decision Blitz begins with identifying the decision pattern(s) that are relevant to the project type/scope. Generalized decision patterns exist for Enterprise Strategy (Business Design), Process Capability Design, System/Product Design, Service Design and Curriculum/Courseware Design.[4] The business situation may call for a composite of these patterns, e.g., a weapons system design, the manufacturing process design to build the weapons system, the support system process design and the operator training design. Ultimately, the appropriate patterns should address the decisions needed to design the primary deliverables on the Project Work Breakdown Structure.

Commercial products aren't created in a vacuum. As shown in Figure 1, a set of business strategy and scoping decisions concerning enterprise vision, value chain strategy, target markets and market positioning lead to product/services portfolio decisions. New product concepts are evaluated for their fit within and contributions to that portfolio and may cannibalize existing products and services by taking over their use cases as well as supporting new ones.

These enterprise decisions set the business context for any product, service, platform or even for facilities and other forms of business infrastructure. The answers chosen create derived requirements and goals for revenue, profitability, product/service differentiation and standards compliance that flow down to individual products and services within the portfolio.

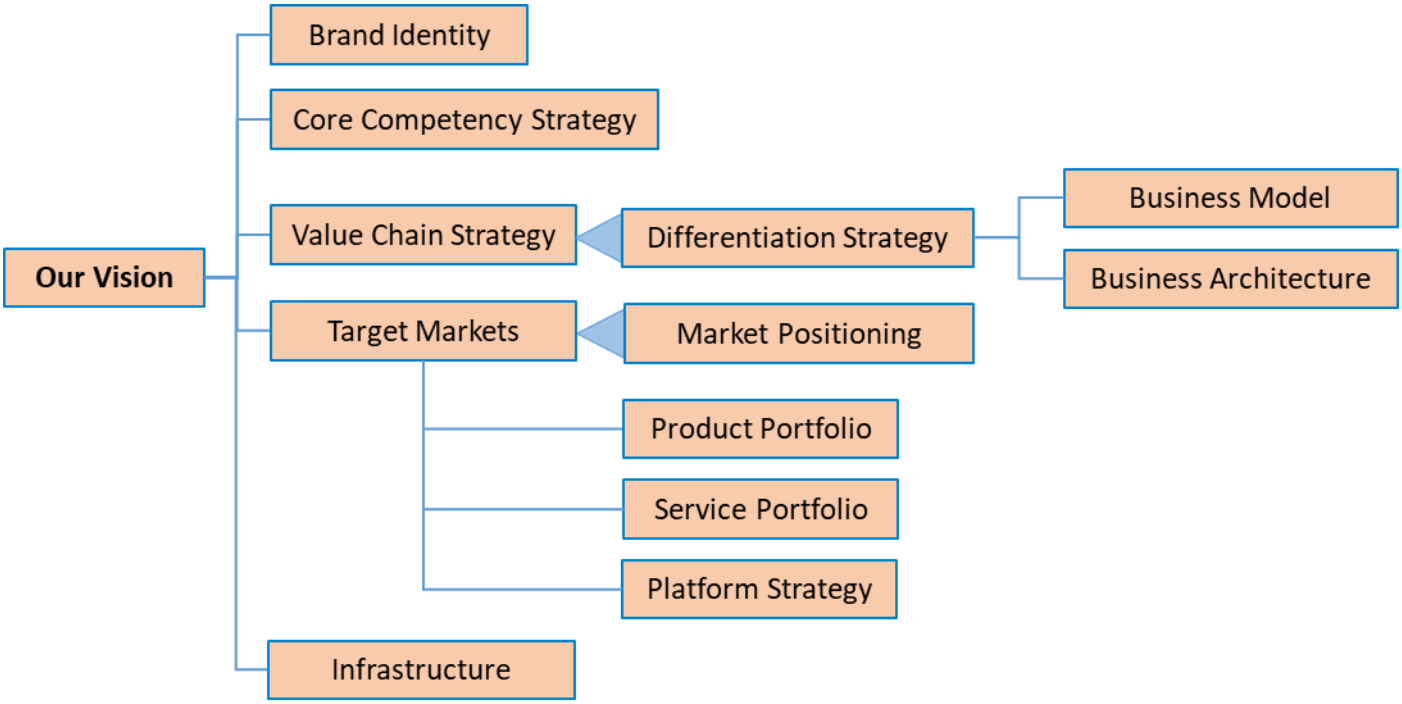


*Figure 1: Enterprise Strategy decisions set the business context for a product, service or platform*

Product scoping decisions, as shown in Figure 2 and elaborated in Table 1, begin with the choice of which mission scenarios or use cases the product (at this point, just a concept) will support. N out of M possible use cases may be chosen; others will be rejected or deferred to future releases. For each use case that is chosen, you may evaluate your potential value proposition against the status-quo and potential competitors to ensure that your solution stands out. A decision on the use case flow (or user experience) then follows, evaluating various sequences of user and system actions. However, the product could play a minimal role in some use case or provide a highly-automated or autonomous solution in others. The product role choice determines which steps in the use case will be supported or fully performed by the product rather than by manual user actions. Finally, stakeholders often decide how they wish to package functionality "for sale", i.e., define the sets of features that can be separately activated or provisioned depending on user subscriptions.

NOTE: Use cases and feature sets that are deferred to future system releases should be accounted for in the system requirements in order to drive the solution architecture.

From my experience, stakeholders often overlook many of the potential use cases for their products or fail to capture the wide variety of environmental conditions or situations under which a use case may be performed. And simply naming a use case without considering how the solution will maximize stakeholder value through a better user experience often leads to missed functional and performance requirements.

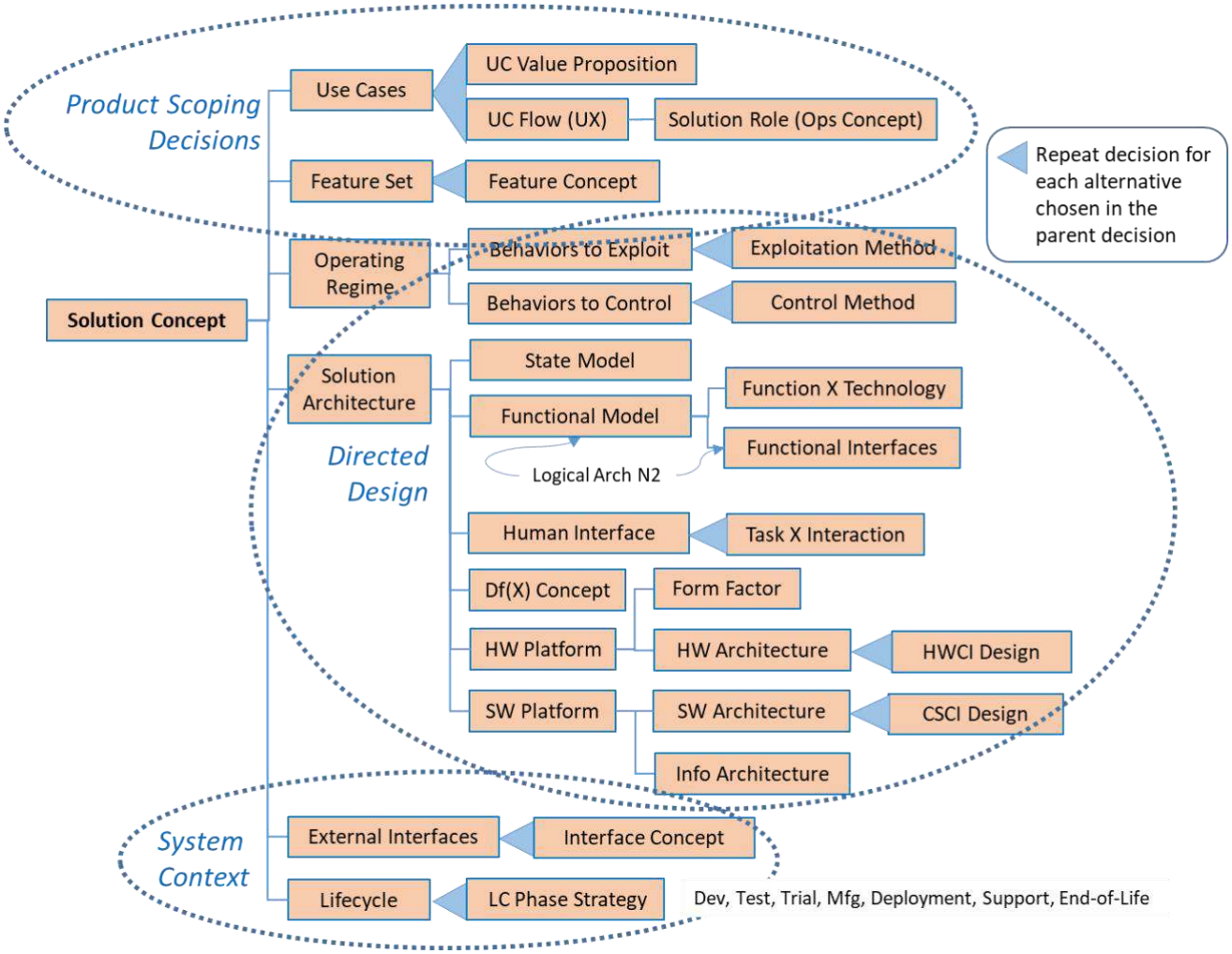


*Figure 2 – System/Product Design Decision Pattern*

The technique used when reverse engineering is a bit like mining for precious metals or gems. The requirements analyst reads carefully through the originating requirements or other documents that describe the mission or business context, looking for noun phrases, e.g., adjective-adjective-noun, that represent directed solutions within the requirements. For each directed solution, ask "If <DirectedSolutionX> is the answer, what was the question?" where the questions represent an instance of a decision within one of the relevant decision patterns.

| Decision Name | Decision Description | Alternative(s) |
|---|---|---|
| 1 Solution Concept | What is the top-level concept for this system or solution? What makes it unique? | |
| 1.1 Use Cases to Support | What use cases (scenarios, missions) will this solution support? | |
| 1.1.1 Value Proposition | How will the solution deliver value to the end users and customers of this use case? (For each use case chosen in 1.1) | |
| 1.1.2 Use Case Flow | How will this use case be performed? What flow of activities and events will occur? (For each use case chosen in 1.1) | |

| Decision Name | Decision Description | Alternative(s) |
|---|---|---|
| 1.1.2.1 System Role | What role with the system play in this use case? What capabilities and value will it deliver? (For each use case chosen in 1.1) | |
| 1.2 Feature Set | What are the primary features or groups of features that will be delivered? | |
| 1.2.1 Feature Concept | How will this feature be implemented (technology, top-level design)? (For each feature chosen in 1.2) | |

*Table 1 – Product Scoping Decisions*

For example, I recall the specification for a combat vehicle that included a requirement for a "two-bottle halon system" on-board for fire suppression. It was obvious from the context and a limited knowledge of technology, that the directed solution answered the question (aka decision): *Choose* Fire Suppression Solution Concept which is an instance of the more general decision: *Choose* FunctionX Technology as shown in Figure 2 (at level 4 in the middle-right section). That led to requirement issues to be addressed with the stakeholders as to:

- Why halon? (the directed technology alternative)
- Why 2-bottle? (the directed solution architecture)

The directed solution turned out to be a fleet-wide preference to reduce the logistics footprint. In this case the directed solution was validated as a requirement for this vehicle.

Often (and thankfully so) the requirements will not direct solution technologies or physical architectures, but implicit technology choices may be inferred from the way the requirements are stated. A requirement worded as "the vehicle shall have a range of 500 kilometers (under certain load and driving conditions) between recharging cycles" likely implies that the stakeholders are looking for a vehicle with an electric propulsion system and some type of battery as the energy storage method.

Such assumptions concerning stakeholder intent would be captured as hypotheses (implied solution alternatives) in the Decision Blitz as shown in Table 2:

| Decision Name | Decision Description | Implied Solution Alternative | Derived Requirement |
|---|---|---|---|
| Choose Propulsion System Concept | What technology, method or solution concept will be used to deliver the Propel the Vehicle function? | Electric propulsion system | Range between recharging |
| Choose Energy Storage Technology | What technology, method or solution concept will be used to deliver the Store Energy function? | Battery (chemistry TBD) | Range between recharging |

*Table 2 – Decision Blitz Example with Implied Solutions (Hypotheses)*

Note that there is nothing in the requirement that demands a particular battery technology. That would be an open question (requirement issue) to address with the stakeholders during the face-to-face portion of the Decision Blitz.

The requirements analyst is intentionally taking the viewpoint of the stakeholder in this process, replaying in abbreviated form the stakeholder choices that have shaped their implicit idea of a solution, as expressed in system requirements.

In a more complete example, the analyst would capture an alternative description to better clarify the directed or implied solutions. These natural language solution descriptions may also be augmented by physical architecture models (components and interfaces) and logical architecture models (functions with control flow and item flow) to clarify the implied solution concepts.

Any of the design decisions in Figure 2 may be made by the system stakeholders and communicated to solution developers as system requirements. However, those shown in the middle oval labeled "Directed Design" take away significant design freedom from the solution developer.

The top-level External Interface decision (shown in the System Context oval in Figure 2) is often made by the stakeholders, but incompletely delivered to the solution developers in the originating requirements handoff. Exploring this decision will often uncover external interfaces that have been overlooked or open decisions concerning how a specific interface should be implemented.

The Lifecycle branch of the decision model (also in the System Context oval in Figure 2) is a top-level view of the design decisions associated with the enabling systems (development, verification, manufacturing, deployment, support and end-of-life) required by the System of Interest. Ideally these enabling systems will be concurrently engineered along with the System of Interest; their design decisions must align with the System of Interest design decisions. However, at the point of the Decision Blitz choosing a top-level strategy for each enabling system may suffice as a source of requirements that will be levied on the System of Interest.

After completing a pass through the originating requirements and source documents, the analyst walks through the resulting decision table to identify decisions in the pattern from which no directed or assumed solution can be inferred. If the full decision pattern is relevant to the problem domain, this "white space" may represent gaps in the stakeholders thinking and therefore gaps in the system requirements.

**Step 2: Validate and Refine Stakeholder Decision Model**

Regardless of the process skills or problem and solution domain knowledge of the requirements analyst, the reverse engineering exercise at the start of the Decision Blitz can only yield a set of hypotheses of what is in the heads of the stakeholders and "behind" the originating requirements. However, these hypotheses are more focused than a few guesses or questions triggered by reading a specification. They reflect fundamental questions that must be answered to define the role of any system or product in the larger world and reasonable inferences that can be drawn from what the stakeholders have provided as requirements.

Validating these hypotheses is accomplished by walking through the decision model with the stakeholders, ideally assembled together, and asking for confirmation or clarification of each hypothesis (implied solution alternative and its validity as a source of the stated requirement).

In the simple case, a stakeholder will confirm the implied solution alternative, add some refinements to the alternative description and explain the rationale for why this solution leads to the system requirement.

But be prepared for fireworks at this point – it is quite common for stakeholders to disagree with one another over the implied alternative and get into heated debates over how "that" idea became

enshrined in the requirements. In such cases, the requirements analyst captures additional alternatives advocated by the stakeholders and marks the decision with Status = Open. Decisions in the pattern for which there are no implied stakeholder answers also are statused as Open. It must be determined later whether these decisions are considered by the stakeholders as "in-scope" for the development project. If the decision pattern is well-adapted to the problem domain, it is likely that either the stakeholders need to make additional decisions before releasing the final specification or they need to fund the solution provider to perform that analysis on their behalf. Proceeding without a plan to nail down these decisions is a recipe for project failure.

Ultimately the face-to-face portion of a Decision Blitz is about gaining stakeholder consensus on their higher-level decisions and then flowing down the consequences of those decisions into the system requirements baseline.

Although a tabular view of the decision model may be sufficient, I have found that providing a graphical visualization of their decisions is an important communication tool to foster stakeholder engagement. As shown in Figure 3, an initial DBS for the project is depicted as a hierarchy with each decision represented as a two-panel box. The top panel includes the decision name (and often the decision number, i.e. its place in the hierarchy). The bottom panel includes the directed or implied solution alternative(s) that have emerged from reverse engineering or perhaps has been refined through the Decision Blitz process.

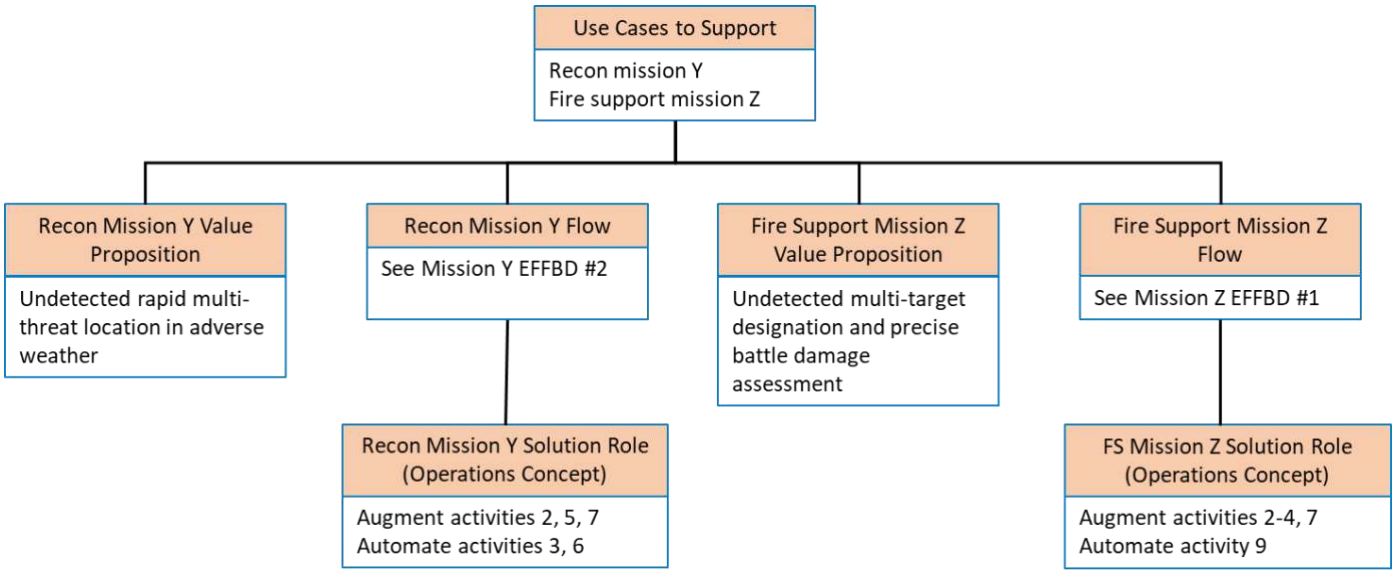


*Figure 3: Decision Breakdown Structure – 2-panel format*

A variety of MBSE tools, drawing tools or Microsoft Excel may be adapted to generate such diagrams.

**Step 3: Derive/Trace System Requirements from Stakeholder Decisions**

At this point in the process, the requirements analyst has gained a reasonable level of stakeholder consensus by making explicit the stakeholders' implicit decisions that created the requirements. The tabular view of the DBS (or more likely the database that drives that view) will have captured the requirements derivation trace from the solution alternatives to the draft system requirements.

This is the time to further exploit the investment made in reverse engineering the decision model. It is highly likely that additional (missing) requirements may be derived from the solution alternatives.

To uncover these requirements, repetitively ask for each "Closed" decision "What additional requirements does the solution chosen impose on the rest of the system?" If you have detailed and precise descriptions of the alternatives, elaborated by physical and logical models of the alternative's structure and behavior, it will help you more efficiently think through the derived requirement consequences associated with each choice. Over the years, I have found a simple heuristic helpful in identifying derived requirements that leads to refining the question stated above to focus on different aspects of the chosen alternative.

*"How does the chosen alternative's Structure, Behavior, Footprint, Interfaces and Lifecycle impose constraints on the rest of the system?'*

The process of uncovering missing derived requirements takes both process skills and domain expertise, particularly knowledge concerning solution technologies. The same individuals who have helped refine the alternative descriptions and models will be invaluable at this point.

**Step 4: Complete System Requirement Analysis**

The decision model and decision-to-requirement trace created in Steps 1-3 provide a launchpad for performing a variety of additional requirements analysis techniques that may be part of a System Requirements Analysis process.

*Context Analysis*

The alternatives identified for the External Interfaces decision should mirror the external systems and human actors that appear on a system Context Diagram. The Interface Concept decision for each external system/actor should further elaborate the physical implementation of each interface, i.e. how the items that flow across the interface will be transferred.

*Design Requirements Analysis*

The reverse engineering process should uncover a majority of the cases where the stakeholders have directly specified or indirectly implied the internals of the solution design, rather than specifying the solution-independent characteristics of the desired system. Both methods use the same technique, i.e., reading the originating requirements looking for nouns or adjective-noun phrases that represent prescribed elements of the system.

*States & Modes Analysis*

Few stakeholders fully specify system states and modes as requirements. Decisions concerning high-level system behavior, e.g., use case variants may help uncover potential system states. The Feature Set decision may also hint toward groupings of functionality that have distinguishable business value and that may be the building blocks of system modes.

*Functional Analysis*

The functions of a system are derived from the system use cases, use case flow alternatives and system-assigned steps in the use case flows. Any work during the Decision Blitz that models the use case flows as a sequence of system and operator steps is a good starting point for performing more rigorous functional analysis during the remainder of the system requirements analysis (SRA) phase.

*Rest of Scenario Analysis*

Rest of Scenario Analysis explores more deeply the conditions under which use cases and associated system functions are performed. Identification of use case alternatives and variants will distinguish different situations in which the System of Interest is employed. A complete description of each use case alternative should include identification of environmental or contextual conditions.

*Stakeholder Value Analysis*

Although the process of reverse engineering starts with originating requirements, stakeholder goals (Measures of Effectiveness) that reflect the value of margin beyond a requirement threshold will likely be clarified in the same process.

*ERA Analysis*

The process of Entity-Relationship-Attribute (ERA) Analysis is encapsulated in the Information Architecture decision in which information classes, the relationships between classes and the attributes appropriate for each class will be chosen. Entity Relationship Diagrams (ERDs) or SysML/UML Class Diagrams represent information model alternatives.

*OCD Development*

Performed across the total set of use cases, the Use Cases to Support, Use Case Flow and System Role decisions populate much of the content of the Operational Concept Description for the product and are a primary source of system functional and performance requirements.

*System Requirements Review*

Requirements, both modified and newly discovered through the Decision Blitz and subsequent requirements analysis processes, should go through standard processes for validation, approval and traceability. A System Requirements Review (SRR) should be conducted to catch and resolve loose ends and gain approval for setting a system requirements (problem definition) baseline. Because of the heavy and direct involvement of stakeholders, the Decision Blitz can be viewed as a preliminary SRR.

**Step 5: Plan Project Design Decisions**

The initial version of the DBS draws a clear line between decisions made by the stakeholders (the source of system requirements) and those to-be-made by the solution developers. This gives the stakeholders and developers a chance to revisit the project work scope and to assess whether it can be accomplished at acceptable risk within the cost and schedule constraints. Figure 4 illustrates a typical DBS, split between stakeholder-owned and developer-assigned decisions.

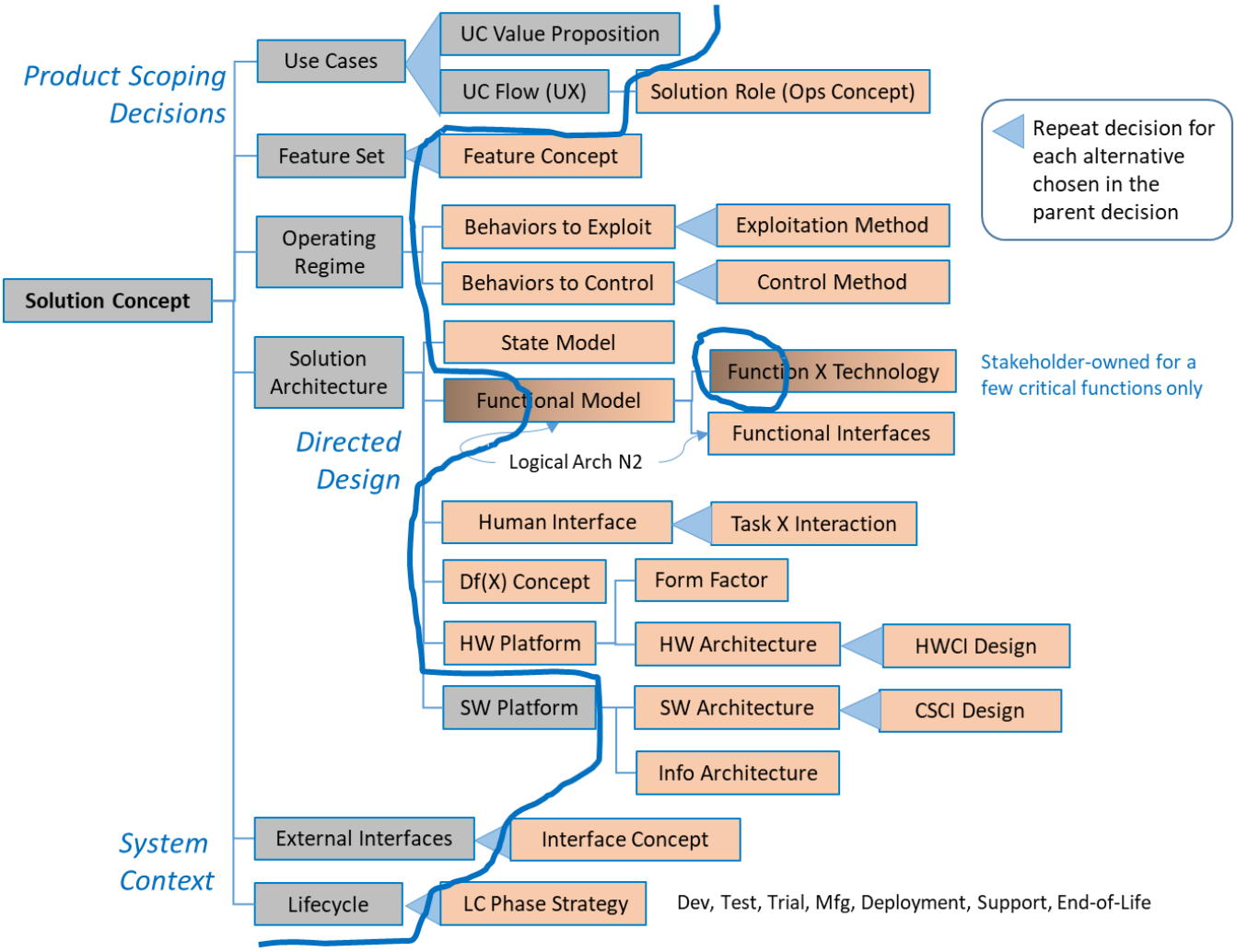


*Figure 4: Decision Ownership Split Between Stakeholders and Solution Developers*

The investment to build a project decision model as part of system requirements analysis pays off not only through improved requirements. It sets up a decision planning and communication framework for the remainder of the project. The DBS provides a comprehensive Trade Study Plan that identifies for each decision the:

- decision owner who will lead the decision analysis.
- decision authority who has the power to approve the recommended alternative.
- cost and schedule budget for the decision analysis.
- analytic methods used to inform the decision with objective data (models, simulations, prototypes, etc.).
- analysis tasks to be performed and their assignments, budgets and schedules.

**Conclusion**

I have had the privilege a training a few thousand professionals on how to use decision patterns to perform the *forward* engineering of systems, products or processes. The process of *reverse* engineering stakeholder decisions for the sake of requirements analysis and validation depends on the same principles:

- There is a decision pattern behind any strategy or design.
- Decisions (through the alternative chosen) are the source of all requirements.
- The Decision -> chooses -> Alternative -> results in -> Requirement traceability thread may be traversed in either direction.

- Elaborating alternatives in the form of detailed textual descriptions and physical and logical models is useful in understanding their derived requirements consequences.

Reverse engineering against a decision pattern is more difficult than forward engineering from the decision pattern because:

- Inferring an implied "upstream" solution alternative from a requirement is a less developed skill among engineers.
- Mapping a stated or implied solution alternative back to a decision depends on a pattern matching skill that demands some level of internalization of the decision pattern. Such skill can be gained only through experience, i.e., multiple cycles of learning in use the decision pattern.

As a first step in gaining these skills, I encourage our readers to practice reverse engineering solution alternatives against the product design decision pattern shown in Figure 2 using a 2-page marketing blurb or data sheet for any product or service as the starting point.

PPI can help you apply the power of decision patterns to your engineering challenges. Look for further announcements concerning our decision-focused services.

In the meantime, please inquire if you have near-term interest in a participating in a decision-focused reverse engineering engagement to help analyze and refine your system requirements. Contact the author at jfitch@ppi-int.com or PPISyEN@ppi-int.com to communicate your interest.

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**About the Author**

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

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

# PPI SyEN SPOTLIGHT: Advancing MBSE

**PPI's René King (R) sat down with Juan Navas (J) from Thales and Stéphane Lacrampe (S) from Obeo Software to discuss all things related to MBSE, digital engineering, the Arcadia Method and the Capella software tool.**

**R: For readers unfamiliar with Eclipse, Capella, or Arcadia, can you please explain simply what each of these is?**

**J:** As systems engineers, and in particular as systems architects, we observe that the skills required to define the architecture of a complex system are not sufficiently acquired during our university years. A lot is learnt through years of successful (or less successful) experiences. Arcadia can be taught as an accelerator to developing those skills: it is a system architecture method, embedding years of experience of systems architects in Thales. By applying the architecture practices defined by Arcadia, our systems architects are applying practices that have been proven in the field in many different industrial domains.

Arcadia practices have been defined in such a way that they can (and in some cases, should) be applied using a tool. Capella, a free-to-use SE modeling tool, is the tool that natively embeds Arcadia practices. In a way, by using the tool and following its guidance, you are automatically following the Arcadia system architecture method. By using the tool and the method frequently, users may start identifying the tooled-up practices that are most valuable for specific architecture concerns.

**S:** Eclipse is both an open-source foundation hosting the Capella project and a technical platform on top of which the Capella tool is built.

**R: What are the fundamental differences between the Arcadia method and the other SE methods that underpin some other SE tools?**

**J:** What stands out for me the most is the strong coupling between the Arcadia method and the Capella tool. For example, Arcadia invites the architect to adopt different points of view to analyze the concerns that are relevant to the system we are designing. In particular, Arcadia encourages an in-depth analysis of the problem space before proceeding to the definition of the architecture that will solve these problems. In practice, Capella gives you the possibility to work on five different perspectives, which could be taught as five different architecture models, two of which are focus on the problem-space and three of which are focused on the solution space. Furthermore, Capella helps to ensure the consistency between these five different perspectives.

**R: Why is embracing Open Source tools so essential?**

**S:** Honestly, I would not say it is "so essential". I think organizations should take on a holistic approach when selecting the right tool. First and foremost, does the tool do the required job?

Secondly, Total Cost of Ownership (TCO) is worth considering - a tool may be free to use however that does not mean that the TCO is $0. When doing a professional deployment, there is a good chance you will require additional services and commercial add-ons.
The quality of the tool ecosystem is also an important aspect to consider: the ability to exchange with the community on the tool, the ability to find professional services and add-ons, and the ability to contribute to the product roadmap and co-finance its evolution with other users. This may translate to more involvement in the tool roadmap and development for organizations. Still, as tools are a

significant part of digital engineering, I believe investing in the right tools is a crucial strategy to mitigate vendor lock-in.

**R: What are the elements of a good model?**

**J:** A good model is a useful one. This may seem obvious, but it means several things! First, it means that it should be useful for the people that will use it, which means that we should identify these people, their expectations, and their capacities. For instance, in some cases we work with our customers to define a common language and the concepts that we will use during our technical reviews; for this, the openness and availability of Arcadia and Capella is a major asset, as our customers can have access to it very easily.

A good model is an accurate, consistent and complete (for purpose) one. When modeling in a model-based systems engineering software, a good model will enable the software to perform automatic operations leading to a consistent design. For instance, when you change the component to which a function is allocated in a diagram, all diagrams will be updated, which is extremely efficient.

**R: What are the critical skills of a good SE modeler?**

**J:** I do not really like the term "SE Modeler". In my opinion, it implies that there is somebody doing only modeling, meaning using a modeling tool, and somebody else doing the system architecture design. I can understand why some companies use this role to produce system models when architects are reluctant to use a tool as a short-term solution. However, when we as an engineering community have the ambition to embrace and welcome the digitization of engineering practices, it should be our goal that all engineers embrace MBSE practices and tools.

**R: What do you see as the most potent capability of Capella?**

**J:** There are many features I like very much! The first one that comes to my mind is how easy is to create elements such as functions or components in Capella. Going a little bit deeper, Capella is configured by default for creating instances of elements, instead of having to define the type of the element first, and then their instances. Also, I as the user may decide that a function or component, or an assembly of functions of components, shall be reused in the system architecture or in another system. Users can create a reusable definition out of my instances. For those with an electrical engineering background, think of it as being able to include five 330 ohm resistors in a circuit, without needing to define a '330 ohm resistance' type before.

**S:** Beyond Capella itself, I think it is worth mentioning what I believe is a pretty unique feature in the modeling tool landscape: Team for Capella. Team for Capella is a commercial add-on, enabling Capella users to work in a live concurrent manner on Capella models. This real-time editing feature is similar to what you will be familiar with in Google applications such as Google Docs (for example) or any cloud-based, multiple-user software that has real-time updates. Users are able to work on the same models and diagrams as model elements and updates happen completely transparently and instantly. The result is a smooth and efficient collaboration of team members during their modeling activities. This means that less time is spent working on different models and attempting to merge various models and diagrams.

**R: What is Capella's update strategy, and why?**

**J:** Capella may be thought of as a platform. The core of the platform is updated once per year and the surrounding elements undergo minor updates on a more frequent basis. Evolutions of the core are driven by users' needs that require working at the core level. There is also the Capella ecosystem that includes companies that provide extensions to the tool and enhance the capabilities of Capella. These extensions, of course, have their own life cycle and update strategy.

**R: What do you see as the biggest challenge to the proliferation of MBSE?**

**J:** I think the biggest challenge is for us to smooth the learning curve by embracing a modeling language or method that uses terminology that is already familiar with engineers and ensuring that the tools that support modeling of the language or method are closely coupled for more intuitive modeling.

**S:** That is a great question, and I think that on this matter, the SERC released a study in March 2020 titled "Model-Based Systems Engineering Maturity Benchmark Survey". This study shows that there are still a lot of challenges for MBSE. I think one challenge that will stay can be categorized under "change management". MBSE involves transforming engineering practices and breaking silos. The human aspects involved in these transformations are always challenging. Getting help from an experienced MBSE coach is probably one way to avoid some pitfalls in this matter.

This study also identifies "MBSE methods/process" as the main obstacle.
I believe this is one of the most significant challenges today: companies tend to set up MBSE with system engineers still working in the same way while modeling experts construct the models. Most of the time, this results in the modeling experts learning a lot about the system they model but not necessarily that much with system engineers learning about MBSE...

**R: How do you define digital engineering?**

**J:** For me, digital engineering first means to acknowledge how our lives are being transformed very rapidly with the ever-stronger coupling between humans and technologies that exploit information. Then to apply and adapt these transformations to improve the quality and productivity of engineering.

**What role does MBSE play in fostering digital engineering?**

**J:** MBSE is at some extent only the beginning of a long Digital Engineering journey. MBSE has allowed us to validate the feasibility and the benefits of digitizing the system design tasks and of having a digital representation of the system design. Nevertheless, if we want to extend these benefits to a larger scope of engineering, we will need to address much better the heterogeneity of the profiles that will be actors of such a transformation. Or said differently, a lot has to be done to “democratize” model-based engineering!

**If I’m interested in using Capella but have no clue where to start, what shall I do to get started?**

**S:** For those wanting a quick overview of the Arcadia method and the Capella tool, the video "The spirit of Arcadia and Capella in 7 minutes" is ideal: https://www.youtube.com/watch?v=BtzhlZUaWA8

Now, if you want to try the tool, set up is very simple, download Capella (https://www.eclipse.org/capella/download.html), unzip, and launch it.

From there, I like to point to this excellent tutorial for the Singapore University of Technology and Design featuring... a toy catapult. It is detailed and will get you through your first modeling experience with Capella without any bumps: https://esd.sutd.edu.sg/40014-capella-tutorial/index.html .

**Stéphane Lacrampe** co-founded Obeo in 2005 in France. Obeo is an independent software vendor with a global reach, leading in open-source modeling software for system and software engineers, enterprise architects, and domain modeling experts. Stephane Lacrampe acted as the CEO of the company until 2018 and is now the director of Obeo Canada. Stéphane LACRAMPE is in charge of developing the Capella ecosystem in North and South America. Stéphane LACRAMPE is also the co-chair of the INCOSE Systems Engineering Tools Database Working Group.

## SPOTLIGHT

**Juan Navas** is a Systems Architect with +12-years' experience on performing and implementing Systems Engineering practices in multiple organizations. He is in charge of the Thales Corporate Modelling & Simulation expert team and dedicates most of his time accompanying systems engineering managers and architects when implementing MBSE approaches, helping them define the best-suited engineering practices to put in place in their own context. He holds a PhD on embedded software engineering (Brest, France), an MSc Degree on control and computer science from MINES ParisTech (Paris, France) and Electronics and Electrical Engineering Degrees from Universidad de Los Andes (Bogota, Colombia).

### *PPI RESOURCES*

PPI offers a multitude of resources available to all of our clients, associates and friends! Click on any of the links below to access these resources today.

**Systems Engineering FAQ:** https://www.ppi-int.com/resources/systems-engineering-faq
Industry-related questions answered by PPI Founder and Managing Director Robert Halligan.

**Key downloads**: https://www.ppi-int.com/keydownloads/
Free downloadable presentations, short papers, specifications and other helpful downloads related to requirements and the field of Systems Engineering.

**Conferences**: https://www.ppi-int.com/resources/conferences-and-meetings/
Keep track of systems engineering-relevant conferences and meeting dates throughout the year.

**Systems Engineering Goldmine**: https://www.ppi-int.com/se-goldmine/
A free resources with over 4GB of downloadable information relevant to the Engineering of systems and a searchable database of 7,800+ defined terms. You can expect the content of the SE Goldmine to continue to increase over time.

**Systems Engineering Tools Database (requires SEG account to log in from the Systems Engineering Goldmine)**: https://www.systemsengineeringtools.com/
A resource jointly developed and operated by Project Performance International (PPI) and the International Council on Systems Engineering (INCOSE). The SETDB helps you find appropriate software tools and cloud services that support your systems engineering-related activities. As a PPI SEG account holder, you have ongoing free access to the SETDB.

**PPI SyEN Newsjournal** (actually a substantial monthly SE publication): https://www.ppi-int.com/systems-engineering-newsjournal/
You're already reading our monthly newsjournal! However click on the link to access the history of 100+ monthly newsjournals containing excellent articles, news and other interesting topics summarizing developments in the field of systems engineering.

# SYSTEMS ENGINEERING RESOURCES

*Useful artifacts to improve your SE effectiveness*

**Webinar Series - Transforming Manufacturing Engineering with Virtual Technology**

Dassult Systemes delivered a three-part webinar series in May-June 2022 concerning how to transform the discipline of manufacturing engineering using "virtual build" digital thread technology. The three episodes where hosted by Adrian Wood, Strategic Business Development Director of Dassault's DELMIA product line.

*Episode 1 – What are the Challenges?*

In the first episode, Jim Brown, President and Co-founder of Tech-Clarity, was interviewed to elaborate on the most pressing challenges faced by with manufacturing enterprises:

- Increasing pressure to deliver complex/personalized products to market faster
- Maintaining product quality in the face of increased pace in engineering and manufacturing without incurring additional costs and delays.

Brown addressed six questions to further clarify these challenges:

- What are some of the industry challenges and trends that are impacting Manufacturing Engineering?
- What transformation is needed and who does it impact?
- Does this process apply to all industries equally?
- What are the challenges in transforming manufacturing engineering to higher levels of maturity?
- What metrics are impacted and what does "best in class" look like?
- How do outsources supply chains complicate the problems?

Tech-Clarity is conducting an industry survey to better understand and prioritize these challenges.

*Episode 2 – Understanding the Capabilities and Opportunities*

In the second episode, Brenton Kemmer, a Digital Manufacturing industry process consultant, was interviewed to provide an overview of the capabilities associated with enhancing the manufacturing engineering process with virtual build technology.

Kemmer described five capabilities that comprise a manufacturing engineering process that is enabled for virtual build:

- Manufacturing Bill of Material (MBOM) Definition
- Process Plan Definition
- Validation and Simulation
- Ergonomics Assessment
- Work Instruction Design and Review

Kemmer shared two examples scenarios, process engineering and design for manufacturability, using the DELMIA tool suite to demonstrate these capabilities for a typical discrete manufacturing scenario.

Benefits of the virtual build approach were stated as:

- Concurrent Engineering
- Simulation Tools for Scalability
- Easier management of diversity and configuration
- Accelerate process speed

Typical results were illustrated using the example of Electronics Manufacturing.

*Episode 3 – What are the Possibilities and Future of Transforming Manufacturing Engineering with Virtual Technology?*
In the third episode, Jim Brown of Tech-Clarity returned to share the results of an industry survey on manufacturing engineering and to discuss the potential impact of virtual build technology on this discipline. Stay tuned for more information from this session when it is posted for online viewing.

PPI SyEN recommends these resources to those who are investigating the potential of digital thread technologies that enable the concurrent engineering products and the manufacturing systems that will build them.

**Book: Critical Uncertainties - The Theory and Practice of System Safety**

Matthew Squair, a system safety and risk consultant and author of over a dozen works on these subjects, has self-published, as of June 2022, a new book titled, Uncertainties - The Theory and Practice of System Safety. Available for download and use under a Creative Commons license, this 300+ page work tackles topics such as:

Fundamental Concepts of System Safety

- Systems
- Systems and safety
- What is a hazard?
- Risk
- Uncertainty
- Managing risk and uncertainty
- The psychology of risk
- Ethics and safety

The Processes, Practices and Techniques of System Safety

- The system safety process
- Safety and human factors
- Software safety
- Off the shelf and safety
- Safety cases
- SYSTEMS ENGINEERING RESOURCES

- Appendices provide background information and resources.
- The basics of probability
- Bayes theorem
- Incompleteness in hazard identification
- Hazard checklists
- Uncertainty and risk models
- The hazard risk matrix
- System safety and reasonable practibility
- Measuring assurance

Squair has also published a voluminous blog that addresses risk, safety, security and related topics. The blog provides access to an online course on Systems Safety. SyEN readers are encouraged to check out these resources, including tongue-in-cheek Screwtape posts (on risk/safety) and thoughts for the day.

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**Book: Systems Design and Engineering - Facilitating Multidisciplinary Development Projects**


This 131 page book is written to help systems engineers develop the skills and thought processes needed to successfully develop and implement engineered systems. The authors, G. Maarten Bonnema, Karel Veenvliet and Jan Broenink, have chosen a "hands-on" approach for presenting material rather than concentrating on theory. After an introduction and explanation of how to use this book as a “starter kit” for systems engineering, contents include chapters on:

- Systems Engineering Process
- Systems Thinking Tracks
- System Design Tools
- Systems Engineer at Work

Rather than tightly-integrated end-to-end methodologies, the book presents numerous thinking techniques (e.g., Operational, Hierarchical, Life-Cycle), visualizations (e.g., Context Diagram, N2 Diagram) and tools (e.g., Functional Modeling & Analysis, FunKey Architecting, Risk Management) that the authors have found useful in the practice of engineering systems. Appendices are included that address TRIZ innovation techniques and Failure Modes and Effects Analysis (FMEA).

Published 15 December 2015 by CRC Press; ISBN 9781498751261
See details and purchase options here.

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**System Dynamics Society Recognizes Additional 2022 Conference Sponsors**


In the month before the 2022 International System Dynamics Conference (ISDC2022), scheduled for 18-22 July, the System Dynamics Society (SDS) continues to recognize the contributions of its many sponsoring organizations. Check out the contributions of these organizations to the field of system dynamics and systems thinking.

## SYSTEMS ENGINEERING RESOURCES

**Forio Business Simulations**

Forio, a long-term ISDC conference sponsor and exhibitor, creates engaging experiences that train the world's top corporations and universities in leadership, negotiation, operations, forecasting, and management. Forio develops software products that enable simulations, data explorations, and predictive analytics.

Learn more about Forio here.

***Systems* Journal**

*Systems* is an international, peer-reviewed, open access journal on systems theory in practice, including fields such as systems engineering management, systems-based project planning in urban settings, health systems, environmental management, and complex social system.

Learn more about the *Systems* journal here.

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**Sage Analysis Group**

Sage Analysis Group is a strategic management consulting firm that uses advanced modeling and data analytics to help leaders in both industry and government with highly complex, important issues, challenges, and opportunities. Sage's analyses integrate and leverage quantitative data, qualitative information, and expert insights to help clients with key decisions. Sage leverages mature Data Science and System Dynamics modeling capabilities to identify causal drivers and holistically assess complicated, counterintuitive behaviors in complex environments.

Learn more about Sage.

**Additive GmbH**

Additive is a software and hardware company located in Germany that has been dedicated to creating solutions for measurement technology and technical-scientific applications from standard products and individual engineering services for over 30 years.

Learn more about Additive software and hardware services and how they relate to System Dynamics and simulation modeling here.

The SDS also notes the contributions of additional university partners including the University of North Dakota, University of Louisville, and University at Albany.

Check out a previous article in SyEN edition 112 (May 2022) for recognition of additional ISDC sponsors and contributing organizations.

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**NIST Cybersecurity Framework - Analysis of Comments**

The U.S. National Institute of Standards and Technology (NIST) Framework for Improving Critical Infrastructure Cybersecurity (also called Cybersecurity Framework, Framework, or CSF) was released in February 2014 after extensive public engagement and collaboration.

The Framework serves as a prominent resource to manage cybersecurity risks holistically across an organization. It has been downloaded over 1.7 million times and is used by organizations of varying sectors, sizes, and locations. It has been adopted internationally, with the English version complemented by nine translations. The CSF was intended to be a living document that is refined, improved, and evolves over time to keep pace with technology and threat trends, integrate lessons learned, and move best practice to common practice.

Pursuant to that philosophy, NIST asked, in February 2022, for public feedback to evaluate the CSF, alignment of the Framework with other resources, and efforts to improve cybersecurity supply chain risk management. In response, NIST received more than 130 comments, which are available on the Cybersecurity Framework website. NIST has published a Summary Analysis of the RFI comments. Comments covered important issues like cybersecurity risk management, supply chain cybersecurity, cybersecurity metrics, privacy, and emerging technologies.

Based on this feedback, NIST is planning to work with stakeholders to revise the CSF. Learn more about how to engage in the update process here.

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**ACM TechTalk: Lessons From the Fifty-Year Quest to Turn Programmers into Software Engineers**


The above-named talk, shared by Adam Barr, software consultant at Crosslake Technologies with 20+ years prior experience with Microsoft, is available from the Association for Computing Machinery (ACM) Learning Center.

*Abstract*

The term "software engineering" was first used in the title of a 1968 conference organized by NATO, at which academics and industry professionals met and agreed that software needed more engineering focus. A follow-up conference a year later, attempting to solve the problem, instead highlighted the gap between industry and academia. *This split has widened in the intervening years, and software continues to lack the experimental basis of other engineering disciplines*. Instead there has been a succession of what Fred Brooks called "silver bullets," such as object-oriented programming and agile—attempts to find one single technique to address the complexity of software development. This talk discusses the history of the industry/academia split, the attempts to solve the problem, and how modern software techniques, while still lacking the silver bullet, are finally making progress.

*Key points*

- There is a distinction between the Program (created by the few developers, often users themselves) and the Programming System Product (written by multiple teams over a long period of time). Academia focuses on educating for the former; industry the latter. But what is learned about how to do the former has little value with the latter.
- There is no silver bullet (nor likely will ever be), either technology or management technique, that will offer order of magnitude improvements in software productivity, reliability or simplicity. But many silver bullets have been proposed, e.g. structured programming, Object-oriented programming, design patterns, Agile, DevOps, etc. All of these methods are useful improvements, but not silver bullets. Few claims associated with these methods have been backed-up by research, experience or mathematical rigor.

- Ever since the personal computer became available, nearly all programmers learn to program before studying programming formally in school. This is not a coincidence; it is the problem, i.e. the root cause of split between academia and industry.
- Software education is yet focused on languages and algorithms, suitable for small-scale developments, not how to create and structure a large body of complex code such that it is reliable and maintainable. It is difficult to unlearn this individual, intuitive approach to problem-solving.
- Coding camps are, in part, a way to fill the gaps between industry needs and academic offerings.
- Software engineering programs do not prepare students well to answer important questions, e.g., which programming language to use or how reliable is a software component?
- "Experience is a dear teacher, but fools will learn at no other." (Benjamin Franklin)
- "Optimization is the root of all evil (in software)." (Adam Barr)
- The next generation of programmers have to be much more competent (in terms of precision and productivity) than the first generation.
- Cloud services are making things better – much closer to engineered software.
- Empirical studies are coming back as evidenced by journal papers and conferences. But much of this knowledge doesn't often transition to working developers in a timely way.

The talk ends with recommendations for individuals with different software roles in how to learn the level of software engineering skills required by industry today.

PPI SyEN found this talk to be insightful in diagnosing a significant challenge facing companies that develop software-intensive solutions. Engineers with limited software experience or interest may also find the principles presented useful as they attempt to learn systems engineering techniques that demand different disciplines than those taught in their undergraduate coursework. Barr's use of entertaining quotes from early software engineering luminaries reinforces the unchanging need for engineers to remain humble about what they know and continuously learn new and broader skills in the face of ever-increasing product complexity.

Register here to view the talk.

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*In defining engineering terms, a good place to start is the Oxford or Merriam-Webster's English Dictionaries.*

**Robert Halligan**

# FINAL THOUGHTS FROM SYENNA

Dear Reader,

This month I have somehow become sensitised to something that I will call dimensional blindness.

It all started when I had a home charger point installed for my electric car. We only have a 60A fuse for our mains electricity supply and, believe it or not, no mains isolator switch. I phoned up the infrastructure owner to say that I needed a bigger fuse and an isolator.

“Oh yes”, they said, “you need more Volts”.

“Really?” says I, “I was thinking more Amps”.

“Oh yes, I’m always getting those mixed up” came the reply.

If the infrastructure owner doesn’t know the difference between potential difference and current, we have quite a long way to go on our low carbon transition projects.

A more endemic problem is a blindness to the distinction between mass and weight, leading to a happy-go-lucky use of “kg” and “lb” where “N” and “lbf” would sometimes be more satisfactory.

In order to reduce our carbon footprint, we are looking to get rid of our home gas boiler, and I’ve found the heating profession to be fuzzy on the difference between energy (typically measured in kWh) and power (typically in kW). The brochure for a new kind of hot water tank quoted its heat loss rate as “Kw/hour”. The supplier was “an expert in all types of heating systems, with a particular interest in the transition to low carbon solutions”.

The same disease seems to affect the electric car population: “100 kWh rate of charge is the max (ish) you can expect under ideal conditions”.

The next example is probably an oversight rather than a lack of understanding: a prestigious journal quoted the cruising altitude of an aircraft as “30,000 lb”. Presumably, that should have been “lbf”.

Lastly, I have an example that goes back to my teens. I remember my physics teacher insisting that instruments should be labelled so as to be non-dimensional. Examples: a speedometer should be labelled “speed/$kmh^{-1}$” and a range-finder as “range/m”. He asserted that every car tachometer in the universe has been mis-labelled (although they were only present on exotic cars back then). Mostly they say “rpm x 1000” instead of “engine speed/1000rpm”).

My father told the story of his friend who went to pick up a brand-new luxury car from the dealer – a journey of about 100 miles each way. The tachometer was labelled as “rpm x 100” (we know what that means) and marked out as “0”, “10”, “20” etc. The dealer told the friend not to exceed 50 miles per hour for the first 100 miles, otherwise the engine could be damaged. When the friend got home, there were burning smells and steam escaping from the engine, with alarming noises as it started to cool down. The friend had driven all the way home with the tachometer on 50.

Does dimensional blindness niggle you? If so, please share your examples!