SYSTEMS ENGINEERING NEWSLETTER

PPI SyEN 92 – 25 August 2020

Dedicated to inspiring and improving the practice of systems engineering

brought to you by

Project Performance International (PPI)

Systems engineering training and consulting for project success

Welcome to the latest edition of PPI SyEN, PPI's monthly publication filled with informative reading for the technical project professional. In this issue, as well as in tons of archived issues available free at www.ppi-int.com, you will find powerful ideas that may help you prosper in the highly competitive world of systems and product development.

Access a mix of news, quick tips, short reads and deep article content that will help you expand your professional skill set, keep up to date on events and activities of interest, and quite possibly unlock levels of project performance you've never before considered possible.

We hope that you find this newsletter to be informative and useful. As the leading provider of systems engineering training worldwide, PPI is passionate about improving project outcomes. Thousands of professionals in aerospace, medical, consumer and other major sectors subscribe to PPI SyEN, as do leading thinkers in academic, government and scientific organizations.

Our editors strive to bring you a diverse range of views and opinions each month, but please know that the views expressed in externally authored articles are those of the author(s), and are not necessarily those of PPI or its professional staff.

Have a topic you would like to learn more about, or possibly ideas you'd like to share with others? We'd love to hear from you! Just email us at syen@ppi-int.info

We would also love it if you shared this edition with others who may benefit, and we encourage you to join our active community on LinkedIn. If a colleague sent you this copy, you can easily receive future newsletters directly by signing-up using the form at www.ppi-int.com.

Should you no longer wish to receive PPI SyEN for any reason, simply unsubscribe by clicking the link at the bottom of this email.

IN THIS EDITION

1. Quotations to Open On

Read More…

2. Feature Articles

2.1 Industry 4.0, Digital Twins, and Generative Design Explained *by Michael P. Papazoglou*

2.2 Design of Purposeful Human Activity Systems *by Dr. Javier Calvo-Amodio*

Read More…

3. Notable Articles

3.1 Resilience of Engineered Systems: A Typical Scenario *by Scott Jackson*

3.2 The Scientific Academy for Service Technology (ServTech) Potsdam, Germany

by Professor Bernd Krämer

Read More…

4. Systems Engineering News

4.1 Who is an Effective Systems Engineer?

4.2 Evolving Standards from Documents to Tools

4.3 Passing of Professor Emeritus Arthur Sanderson Paul

4.4 Call for Papers: 4th International Conference Complex Systems Design & Management Conference (CSD&M) - Asia

4.5 Job Opportunity: Powertrain Systems Engineering Practitioner

4.6 INCOSE ASEC 2020 is Going Virtual

4.7 Vitech Blog Post: Controlling the Complex Adaptive System

4.8 SESA National Speakers Event 25 August 2020 Autonomous Road Transport – A Systems Approach

4.9 Call for Presentations and Training Workshops for the 2nd Annual INCOSE New England Fall Workshop

Read More…

5. Featured Organizations

5.1 Digital Twin Consortium

5.2 Cynefin Centre for the Application of Complexity, Bangor University, UK

5.3 Sigma Theta Mu Association

5.4 American Society of Mechanical Engineers (ASME)

5.5 Netherlands Organization for Scientific Research

Read More…

6. News on Software Tools Supporting Systems Engineering

6.1 Innoslate 4.3 Released to the Cloud

6.2 Sparx Systems Announces Enterprise Architect 15.2 Beta

Read More…

7. Systems Engineering Publications

7.1 Worldwide Directory of Systems Engineering & Industrial Engineering Academic Programs

7.2 Unifying Themes in Complex Systems IX

7.3 Architecting Systems - Concepts, Principles, and Practice

7.4 Software Engineering in the Systems Context: Addressing Frontiers, Practice, and Education

7.5 Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-Connected World

7.6 Effective Model-Based Systems Engineering

7.7 INCOSE INSIGHT Practitioners Magazine - Volume 23, Number 2

Read More…

8. Education and Academia

8.1 Master's in Intelligent Engineering Systems - Izmir University of Economics, Turkey

8.2 Rensselaer Polytechnic Systems Engineering and Technology Management (SETM) – Troy, New York

Read More…

9. Some Systems Engineering-Relevant Websites

Read More…

10. Standards and Guides

10.1 ISO 62304 Medical Device Software – Software Life Cycle Processes

10.2 IEEE Software & Systems Engineering Standards Committee

Read More…

11. Some Definitions to Close On

11.1 Digital Transformation

11.2 Digital Twin

11.3 The Cynefin framework

Read More…

12. Conferences and Meetings

12.1 INCOSE Western States Regional Conference (Virtual Conference) September 17-19, 2020

Read More…

13. PPI and CTI News

13.1 VIDEO: PPI Launches A New Course: Interface Engineering and Management (IEM) Two Day

13.2 Medical Device Risk Management: Now Offered Through Five Convenient Half-Day Sessions

13.3 PPI Webinar on Wedge Model™ Now Live on YouTube

13.4 PPI Participation in the Second INCOSE Showcase Webinar

Read More…

14. PPI and CTI Events

Read More…

15. Upcoming PPI Participation in Professional Conferences

Read More…

1. QUOTATIONS TO OPEN ON

"Well implemented, systems engineering nurtures and stimulates creativity."

Robert John Halligan

"Impossible is just an opinion."

Paulo Coelho

"As our case is new, we must think and act anew."

Abraham Lincoln

2. FEATURE ARTICLES

2.1 Industry 4.0, Digital Twins, and Generative Design Explained

by

Michael P. Papazoglou

Honorary Professor University of New South Wales, Sydney, Australia

Honorary Professor Macquarie University, Sydney, Australia

Vice President ServTech: The Scientific Academy for Service Technology, Potsdam, Germany

Web site: https://servtech.info/

Email: mikep@servtech.info

Abstract

Industry 4.0 is fundamentally reshaping the industrial landscape by promoting connected manufacturing solutions that realize a "digital thread" which unites all aspects of manufacturing including all data and operations involved in the production of goods and services. This article provides a brief account of Industry 4.0 and discusses the fusion of generative design with digital twins by describing a model of a customized digital product that ranges from ideation and design to realization.

1. Introduction to Industry 4.0

Manufacturing today occurs in traditional factory-situated shop floors where the focus is on mass production of physical components. Traditionally, manufacturers structured their supply chains around siloed functions such as planning, sourcing, manufacturing, or distribution, and the manufacturing system is typically not completely integrated. In addition, many aspects of the production process, including design, manufacturing, and supply, are increasingly outsourced and remain widely fragmented. However, to thrive, many enterprises are eliminating these boundaries and are creating integrated, connected, end-to-end production networks that are "always-on." This requires reconfiguring supply chains to integrate innovative and disruptive technologies, and also capabilities that align with the overall business strategy. These technologies form the foundation of Industry 4.0 and are coupled with a trend towards products that have smarter, dependable, and secure plug and play integration of digital and physical components, leading towards the possibility of products being highly customizable.

Also known as Smart Manufacturing, Industry 4.0 is marked by a shift toward a physical-to-digital-to-physical connection. Industry 4.0 refers to the next industrial revolution which is fueled by integrating digital technologies with industrial processes. The ideal Industry 4.0 manufacturing enterprise will encompass all aspects of manufacturing, from plant operations to the supply chain, promoting a combination of connected machines, process automation, and manufacturing units. It enables virtual tracking of capital assets, processes, and resources throughout the entire product life cycle, fueled by the advancement of digital technologies. The goal is to create an integrated, automated, and optimized production flow, producing increasingly individualized customer products [1]. The cycle begins from the product idea and extends the design of a digital product to the development of a physical product, all the way to the product delivery for the end customer, upgrades, and maintenance. The end result would be flexible, agile, and innovative manufacturing environments comprising collaborating production units and plants in which performance and efficiency are optimized [1].

The definition of Industry 4.0 covers five important properties [2]:

1. Digitization of all physical assets and processes: Manufacturers expand their existing range of products with complete digital product descriptions as well as developing the capabilities they need to provide services and solutions that supplement their traditional product offerings, e.g., embedded systems, sensors, aftercare, and product support, etc., ensuring that customer needs are met while boosting the performance of the core product.

2. Integration of vertical and horizontal value chains: Vertical integration of production activities within smart factories from product design and development and the various shop floor applications, devices, IoT, robot and equipment, is necessary to enable production. The increased data being generated throughout the plant floor also need to be accessible within higher-level enterprise systems to enable taking relevant production and business decisions. Horizontal integration is combined with vertical integration to offer the prospect of coordination of orders, materials flow and production data, with all geographically dispersed entities, e.g., customers, distributors and channel partners, materials and sub-product suppliers, contract manufacturers, and technology solution providers, to achieve end-to-end, holistic integration through the entire value chain.

3. Control and Visibility: As products move from ideation and development to end of life, the wealth of data produced at every stage of the manufacturing lifecycle can create a product's "digital thread". The digital thread denotes the aggregated, product-specific data stream that combines information from a variety of systems and sources to improve design and manufacturing processes by enabling real-time, data-driven actionable insights and decision-making, and control capabilities. Visibility denotes the ability to combine business transactional data with manufacturing operational data to gain full visibility and control and improve decision making and action taking. It also includes real-time tracking and monitoring to prevent raw material, human or machine deviations or failures.

4. Actionable insights: The convergence of the Internet of Things (IoT), processes, and analytics is generating a new world of big data, which is enabling new capabilities such as tailored customer offerings, predictive solutions, streamlining production processes, and adaptation to changes. The use of detailed analysis of manufacturing and sensor data from the plants combined with other critical data elements sets the foundation for greater optimization of overall business and control, better manufacturing and operations planning, greater improvement of production processes and product quality, and more efficient maintenance of production assets.

5. Human-centered automation: Industry 4.0 will lead to a structural shift towards an integrated digital and human workforce where the focus is on improving the user experience, so that information is presented in the context of manufacturing tasks performed, leading to better decision-making.

Digital development needs to captivate the growing expectations of today's customers for product customization, introducing novelty, and getting products to the market faster. The emergence of digital products has reintroduced the concept of product customization at a wider scale. Creating innovative products that customers demand requires manufacturers to develop an outside-in, customer-centric process that can react quickly to changing needs and incorporate customer and product designer feedback. It also requires designing product parts, adjusting processes, and modified production lines for ease of manufacturing of end products with an end goal of making a better product at a lower cost. This can be achieved by optimizing, refining, and making product design and development more nimble to react to customer expectations and market pressure. This is where AI technologies are becoming handy as they are demonstrating that they can provide help in automating product design and transform customer experiences as well as a much-needed productivity boost.

2. Digital Product Lifecycle

In discrete manufacturing every manufactured product passes through a standard lifecycle on its path from product concept, through engineering development, to production. The digital product lifecycle in discrete manufacturing usually encompasses the following stages [2]:

Product Ideation/Analysis: This stage includes interaction with customers, and brainstorming, collaboration, and 'ideation' of a digital product's potential and possibility with product designers and strategists. The objective is to determine and analyze the different product characteristics, usually by improving an existing product or designing a new product from scratch, as well as variants as part of requests for quote for customized products.

Product Design: This stage covers the techniques, digital tools, and expanded mind-set used to design, simulate, and plan a product. Its objective is to provide a virtual version of a product and all of its variations that can be run through wider ranging tests. The concept of a digital twin is central to product design as it includes design and engineering details describing the product's geometry, materials, components, and behavior of individual parts and assemblies that make up the product. A digital twin of a connected product can provide insight into how the product is behaving in the field, helping to steer product design and provide intelligence for successful service calls. During product design engineering teams see not only static mock-ups of a product or system (the traditional 3D digital mock-up driven by Computer-Aided Design [CAD]), but rather provide insights into its physical behavior, like stress and vibration, as well as behavior associated with software and control systems. A product is first visualized with an engineering design, followed by the creation of a Bill of Materials (BOM). The BOM is a list of parts and materials needed to make a product and shows "what product" to make, not "how" to make it.

Product Planning: During this stage, the design concepts are turned into product requirements and production plans. Planning enables manufacturers to manage manufacturing data, processes, resources, and plant data in an integrated product and production environment. Planning bridges the connection between the product centric view of building a product and the plant centric view of building a product in the plant. Planning enables the development of three models critical to manufacturing:

- The manufacturing process model that provides an accurate description concerning how the product will be produced.
- The production facility model that provides a full digital representation of the production and assembly lines needed to make the product.
- The production facility automation model that describes how the automation and industrial control systems, such as Supervisory Control and Data Acquisition (SCADA) systems, Distributed Control Systems (DCS), and other control system configurations, such as skid-mounted Programmable Logic Controllers (PLC), will support production.

Planning consists of detailed plans explaining the manufacturing process. Within these plans resides in-depth information on the above three models including machinery, plant resources, equipment layout, configurations, tools, and instructions. It also provides a bill of manufacturing processes that contains components and subassemblies and the recipes of operations and resources needed to build the product and stations and cells with the list of operations that can be performed at a particular factory floor station.

Production Execution and Management: Production execution oversees production operations, including functions to control material and product flow between equipment. It includes digitally controlled/sensed equipment, factory floor tools/systems/software, infrastructure systems, and simulations used to optimize production and product quality. It supports production schedule execution and product tracking against scheduled completion times, with adjustments to optimize efficiencies.

Service and Maintenance: Services are seen as an approach to create competitive advantage and market differentiation [3]. The process through which this is achieved is commonly known as servitization. With servitization, traditional products can incorporate additional value services, such as maintenance, upgrades in functionality, condition monitoring, remote communications to resolve issues from a distance, consumption monitoring, pushing information to line workers, production outputs, etc. Servitization is being accelerated by the IoT sensors that can collect huge volumes of data which can be used to improve product quality, reliability, and customer satisfaction.

3. Digital Twins

The manufacturing paradigm championed by Industry 4.0 brings together processes, systems, machines, devices, sensors, valves, actuators, manufacturing systems, and communication technologies. All these systems have both a digital component and a physical interaction with the real world. The result is a "digital-twin" model of the connected 'smart' factory of the future, where computer-driven systems create a virtual copy of the physical world and help make decentralized decisions with much higher degree of accuracy [1]. A *Digital Twin* can be defined, fundamentally, as an evolving digital profile of the historical and current behavior of a physical object or process that helps optimize business performance [4], [5]. The Digital Twin is based on massive, cumulative, real-time, real-world data measurements across an array of dimensions. These measurements can create an evolving profile of the object or process in the digital world that may provide important insights on system performance, leading to actions in the physical world. With the creation of the Digital Twin, companies may realize significant value in the areas of speed to market with a new product, improved operations, reduced defects, and emerging new business models to drive revenue.

A digital twin differs from traditional Computer-Aided Design (CAD), and it does not serve as merely another sensor-enabled Internet of Things (IoT) solution. It is much more than either. CAD is completely encapsulated in a computer-simulated environment that has demonstrated moderate success in modeling complex product eco-systems. A CAD-based simulation focuses on creating a model of a product or process into which designers can introduce and test various design elements, including materials, operating conditions, etc. The CAD simulation is static until a designer introduces a new parameter whereas the digital twin simulation is active as it continuously receives real-time data from its real-world counterpart evolving as real-world data measurements are delivered. Simple IoT systems, on the other hand, measure things such as position and diagnostics for an entire component, but not interactions between product components and the full product life cycle processes. When a digital twin is powered by an IoT platform, it can receive real-world data in real-time and process it, enabling the designer to essentially "see" how the real product is behaving. The real power of a Digital Twin is therefore that it can provide a near-real-time comprehensive linkage between the physical and digital worlds.

The Digital Twin approach enables manufacturers to overlay a virtual, digital product on top of any physical product at any stage of production on the factory floor and analyze its behavior so that product designers and engineers can make informed choices about materials and processes using advanced visualization tools, e.g., 3D CAD/CAM tools, during the design stages of a digital product and see the impact on a physical version of the product.

The ability to combine the Digital Twin approach with support for customized products, improved processes and empowerment of human operators is the key to unlocking the real underlying value of Industry 4.0. Digital twins (DTs) may span three types [6]:

1. *Product DTs* (for efficient design of new products): this provides a digital-physical connection that allows manufacturers to analyze how a product behaves under various design conditions and make necessary adjustments in the virtual world to ensure that the ensuing physical product will perform exactly as planned in the field.

2. *Production DTs* (for improved production planning and production): this helps validate how well a manufacturing process will work on the shop floor before production. It simulates the process using a product DT and analyzes why things are happening through the use of the digital thread to optimize production under a variety of conditions and “what-if” scenarios.

3. *Performance DTs* (for improved quality & performance): this helps capture and analyze massive amounts of data regarding the utilization and effectiveness of digital products to provide actionable insight for informed decision making (including product structure, production processes and performance data).

The value of the Digital Twin in manufacturing offers a unique opportunity to simulate, validate, and optimize the entire production system. It also lets manufacturers simulate and test how the product with all its primary parts and sub-assemblies will be built using the manufacturing processes, production lines, and automation. The DT approach also allows for projecting alternative production sequences and potential for optimizing production lines by allowing visibility in the operations of production systems and manufacturing plants.

A Digital Twin can be considered as the first step in the digital concept, but it definitely cannot be considered an ending point, so long as we speak of the concept of true Generative Design – as described below.

4. Generative Design

For digital product design and development, AI comes into play via a new process called Generative Design. Generative Design supports product designers to develop new products based upon user input and meeting design constraints. It enables a design exploration process in which designs are no longer generated directly by designers but are assisted by learning algorithms. It involves the designer developing a design model with which it interacts to allow the discovery of possible design intents.

Designers or engineers input design goals and parameters such as performance or spatial requirements, material type, manufacturing techniques, resilience, cost constraints, and more into the Generative Design software. Generative technology can take the many specific goals input by a designer or engineer - size, weight, strength, style, materials, cost, schedule, manufacturability - and employ algorithms running in the cloud to produce a number of possible design solutions. The typical process involves a design engineer setting design objectives and parameters in a specialist software package, which then runs numerous iterations, gradually improving the design, then presenting several final options to the designer who can accept a design or edit it. Generative Design is a process that iteratively changes a design from an initial concept to a fully-optimized final model. Incorporating machine learning and advanced simulation, the AI-driven design software can rapidly cycle through thousands or millions of design choices, and test configurations to produce options that would be difficult for designers and engineers to discover and model efficiently [7], [8]. The designer or engineer evaluates the generated design alternatives and modifies the settings for designs that do not work, while the "intelligent" software learns from each iteration. Generative design tools support agile production processes and predictive quality techniques that allow product designers to pursue product customization goals and constraints by generating optimized customized product features. These features meet customer/product designer objectives and domain-specific requirements in terms of product features, quality, time criticality, safety, and security. The intuitive Generic Design software simply requires users to import their CAD files into the platform and define load and design criteria. From there, the software generates optimized designs which are ready to 3D print.

A successful product is not just based on good design – manufacturing awareness or manufacturability is a critical aspect of all design endeavors. Often an otherwise good design is difficult or impossible to produce. This is currently not supported by Generative Design tools. Companies not focusing on design for manufacturability initiatives are at great risk for what can be called the *hidden change cycle*. That is, the process where changes happen in manufacturing and are never reflected back to design. This process inevitably leads to loss of critical information; fragmentation and alteration of design concepts; loss of product and process knowledge; stagnation in original, innovative ideas; and even customer satisfaction issues — all of which are compounded results of this disjointed process.

To circumvent this problem, the project relies on Design for Manufacturing (DFM), the practice of designing products in such a way that they are easy to manufacture. DFM is a set of technology-specific design practices that aim to reduce the cost and complexity of a part or product to make it easier and more economical to manufacture, and eliminate excessive changes down the line.

When Generative Design is combined with the concept of a Digital Twin it is destined to revolutionize the approach to digital design and development and the way it operates. When combined with Digital Twins, Generative Design can optimize designs based on the real-world conditions of the product in the field. Generative Design can work on a real Digital Twin as long as it is able to synthesize and simulate all product properties of the latter, including complete, connected, a digital definition of the product, how it functions, how it is manufactured, production processes and performance data, and how it is serviced. Aggregating the live data from products in the field, Digital Twins can simulate the performance and conditions faced by the average product over its entire lifetime, with real-world accuracy. Armed with this data, Generative Design AI software could then serially tweak the product design and simulate its lifetime performance under real-world conditions until it arrives at the best solution that satisfies the designer's goals.

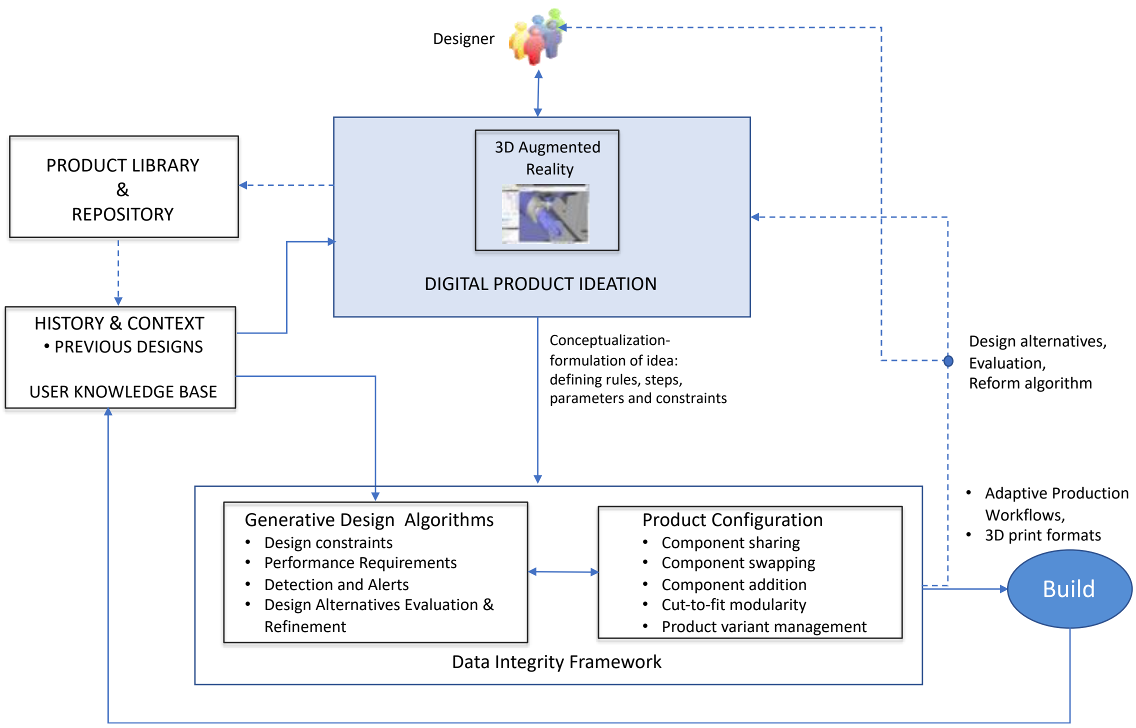


Figure 1: Combining Generative Design with Digital Twins.

Figure 1 depicts the Generative Design process that involves Digital Twins for customized product design and development. This figure illustrates a user-centric customization approach whereby the Generative Design algorithm elicits user requirements at the early stages of a new or an adapted product customization. Figure 1 shows that product customization starts with product ideation, which is essentially a series of sessions that are a formalized part of the product design and eventual development process. Ideation brings together experts such designers, engineers, developers, and customers together in order to leverage their insights, experiences, and ideas. Product and user experience concepts are typically shaped and visualized via sketching and CAD modelling and a broad range of options is visualized through virtual means. Virtual Reality and Augmented Reality are emblematic of product customization. Augmented Reality and Virtual Reality (AR/VR) can enable engineers to test scenarios and designs before the products are made. AR/VR offer the tools that have the ability to view accurate representations of finished products in real-world scenarios, review and evaluate concepts and alternatives, tweak and adjust and modify designs. Importantly product engineers can get cross-functional team input, including potential clients. Lay users can understand a life-like VR/AR simulation, whereas 2D engineering drawings and more complex 3D models can be difficult to interpret if one does not possess a technical background. AR/VR can streamline development, especially when paired with prototyping methods. The result is a reduced technical risk, rapid repetition design cycles and ultimately innovative customized products.

Although the goal of the product customization process can be clear, the outcome that it will produce is difficult to foresee from the outset. Based on input from the part of a user, be it a customer or designer - such as product structural and functional features, product component specifications, and relationships between functional features and component specifications –the product Generative Design and product configuration system and Artificial Intelligence (AI) algorithms in Figure 1 perform the configuration task and produce a customized product solution. The product configuration task involves three main activities: product component selection, component association, and configured product evaluation.

The coupling of Generative Design with Digital Twins is tasking an AI-based Generative Design and configuration system and algorithms with exploring the design space, evaluating alternative customization options and then reporting back to the designer which options it considers promising for further analysis. Such a system allows a much deeper exploration of complex design spaces. In Figure 1, any changes to the design or manufacturing (see dashed lines) automatically flow to all related CAD models, they are documented, and ensuing designs are reported back to the user. Thus, changes become faster and more natural to handle. Product configuration serves as the channel that surrounds all activities that contribute to synthesizing customized products from a set of predefined components, be they parts or assemblies, while respecting a set of well-defined constraints, which restrict how product components can be selected and combined to create a customized product. Once a customized design reflecting the digital part of a Digital Twin is accepted then it is stored in a customized products repository and library along with its solution.

5. Summary and Conclusions

Industry 4.0 is driven by disruptive technologies which promote connected manufacturing solutions that link the supply chain directly to the production line by triggering integrated, automated, autonomous manufacturing processes that make better use of raw materials, and human resources to produce higher-quality products at reduced costs. A digital twin is an inextricable ingredient of Industry 4.0 that has many applications across the life cycle of a digital product that may provide invaluable information regarding product topology, component structure, quality, performance, and customization options, providing a number of value considerations nearly inconceivable just a few years ago. For digital product design and development, Generative Design uses simulation during the earliest product concept stages to identify alternatives that will satisfy design criteria. The human designer then selects the most aesthetically pleasing or otherwise desirable alternative, and completes the design process. When combined with Digital Twins, Generative Design can optimize product designs by synthesizing and simulating all product properties of the latter, including a complete, connected, a digital definition of the product, how it functions, how it is manufactured, production processes and performance data, and how it is serviced.

List of Acronyms Used in this Paper

Acronym	Explanation
3D	3 Dimension
AI	Artificial Intelligence
AR	Augmented Reality
BOM	Bill of Materials
CAD	Computer-Aided Design
CAM	Computer-Aided Manufacturing
DCS	Distributed Control Systems
DFM	Design for Manufacturing
DT	Digital Twins
IoT	Internet of Things
PLC	Programmable Logic Controllers
SCADA	Supervisory Control and Data Acquisition
VR	Virtual Reality

References

[1] Parrott A. and L. Warshaw. “Industry 4.0 and the Digital Twin: Manufacturing Meets its Match”. Deloitte University Press, May 12, 2017.

[2] Papazoglou M.P., and A.S. Andreou. “Smart Connected Digital Factories: Unleashing the Power of Industry 4.0”. In: Muñoz V., Ferguson D., Helfert M., Pahl C. (Eds) Cloud Computing and Services Science. CLOSER 2018. Communications in Computer and Information Science, vol. 1073. Springer, Cham.

[3] Raddats, C., et al.: Motivations for Servitization: the impact of product complexity. International Journal of Operations & Production Management. vol. 36, no. 5, pp 572–591, May 2016.

[4] Grieves, M. “Digital twin: Manufacturing Excellence through Virtual Factory Replication”. White Paper, 2014. Available: https://www.researchgate.net/publication/275211047_Digital_Twin_Manufacturing_Excellence_through_Virtual_Factory_Replication.

[4] i-Scoop: “Digital Twins – Rise of the Digital Twin in Industrial IoT and Industry 4.0”. https://www.i-scoop.eu/internet-of-things-guide/industrial-internet-things-iiot-saving-costs-innovation/digital-twins/.

[5] Papazoglou, M.P. “Metaprogramming Environment for Industry 4.0,” keynote address - 2018 Sixth International Conference on Enterprise Systems, IEEE ICES 2018, pp 1-8, Oct. 2018, Limassol, Cyprus.

[6] Harvard Business Review Analytic Services “The Next Wave of Intelligent Design Automation”. Briefing Paper, June 2018.

[7] Bohnacker. H. et. al. “Generative Design: Visualize, Program, and Create with Processing”. Princeton Architectural Press, October, 2018.

About the Author

Professor Michael P. Papazoglou is a highly acclaimed academic with noteworthy experience in areas of education, research and leadership pertaining to computer science, information systems, industrial engineering and digital manufacturing. He is an Emeritus Professor and Chair of Computer science at Tilburg University where he also was the executive director of European Research Institute in Service Science. He is also a co-founder and vice President of ServTech, The Scientific Academy for Service Technology. He is noted as one of the original promulgators of ‘Service-Oriented Computing’ and was the scientific director of the acclaimed European Network of Excellence in Software Systems and Services (S-CUBE). He is renowned for establishing local ‘pockets of research excellence’ in service science and engineering in several European countries, Australia, and the United Arab Emirates. Papazoglou is an author of the most highly cited papers in the area of service engineering and Web services worldwide with a record of publishing 32 (authored and edited) books, and over 250 prestigious peer-refereed papers along with approximately 20,000 citations. He holds distinguished/honorary professorships at eleven universities around the globe and has forged extensive, longstanding ties to the European industry. His research work was funded by the European Union, the Australian Research Council, the Netherlands Organization for Scientific Research (NWO) and other sources and has served as scientific director of several European Union projects. He has served as an evaluator/appraiser and adviser for several national research bodies and institutes in North America, Europe, Australia, the Middle East, and Asia.

2.2 Design of Purposeful Human Activity Systems

by

Dr. Javier Calvo-Amodio

Javier.Calvo@oregonstate.edu

Dr. Javier Calvo-Amodio provided a summary of his research in a July 10, 2020 INCOSE Webinar. His research focus is on developing an understanding of how to integrate systems science into industrial and systems engineering research and practice. The aim of this focus is on the design of organizational processes that integrate to and/or enhance existing organizational cultures. His research group, Change and Reliable Systems Engineering and Management (CaRSEM), works with Oregon's (USA) industry, state and federal agencies, and other professional societies.

Defining organizations as purposeful human activity systems opens a holistic approach to organizational design that considers the interactions between physical and conceptual systems. From this perspective, is possible to design organizational processes that provide sufficient level of centralized organizational control and cohesion while at the same time enabling autonomy and adaptability to specific units. In this presentation, Dr. Calvo-Amodio provided a brief overview of the theoretical underpinnings for this approach and presented an example concerning how to apply the theory.

Javier Calvo-Amodio, Ph.D. is an associate professor of Industrial and Manufacturing Engineering at Oregon State University, where he directs the Change and Reliable Systems Engineering and Management Research Group (CaRSEM). He received his Ph.D. in Systems and Engineering Management from Texas Tech University, his MS in Business Management from the University of Hull in the United Kingdom, and his B.S. in Industrial and Systems Engineering from Tecnológico de Monterrey in Mexico. He serves currently as the chair of the Systems Science Working Group at INCOSE.

Access the presentation here.

---

3. NOTABLE ARTICLES AND VIDEOS

3.1 Resilience of Engineered Systems: A Typical Scenario

by

Scott Jackson

jackson@burnhamsyastems.net

Since the concept of resilience is recent in academic studies, the associated processes and terminology vary among authors. For that reason, the processes and terminology in this article should only be considered representative of the broader field, and the scenario described is only typical of many scenarios for which the concept of resilience may apply.

Introduction

The concept of resilience is long-standing. Only recently has it become a topic of interest within systems engineering. Traditionally, resilience in a health context has to do with a person recovering from either a physical or mental ailment. Resilience in this context has to do with the ability of the person to return to a normal healthy condition.

In materials science, resilience has to do with the ability of an object, for example a spring, to return to its original shape after having been deformed.

In this article, we discuss a larger class of entities, called engineered systems, and their ability to return to a desired state after being disrupted by any adversity.

Engineered Systems

The systems of interest for this essay are engineered systems. According to Dori and Sillitto (2017), the three main properties of any system are as follows: First, it has to consist of multiple parts. Second, these parts need to interact with each other. Finally, the entire collection of parts (the system), must be able to perform a function that the individual parts cannot. The latter requirement is called emergence. The function of the entire system is an emergent property of the collection of parts.

But how about the term engineered? In current systems usage, the terminology “engineered” simply means to be designed and built by humans. This meaning is broader than the traditional meaning of engineered.

In the context of resilience, the engineered systems may cover a broad range of systems. They may be airplanes or cities. We will focus on airplanes and cities as examples.

Adversity

In the context of engineered systems, resilience can be defined as the ability of the system to maintain capability in the face of the adversity. If the engineered system is a city, the adversity may be an approaching hurricane. In the context of an airplane, the adversity may be the loss of power. The capability to be maintained in the case of the city is normal operation of water and electrical systems. In the case of an airplane, the capability may be the normal cruise speed. In both cases, resilience does not require a return to normal operation. All that is required is a return to a level of capability required by the system owner.

In an earlier paper, Madni and Jackson (2009) identified four attributes that an engineered system should have to be resilient to any adversity. They are as follows: (1) The system should be able to avoid an adversity. This attribute is particularly important when the system can anticipate the approach of an adversity. (2) The system should be able to withstand an adversity. This attribute is important when the system has a direct encounter with an adversity. (3) The system should be able to adapt to the adversity. This attribute is particularly important when the system desires to restore a prior capability. (4) The system should be able to restore its capability to a prior level specified by the system owner. To comply with all these attributes will require a combination of design techniques within the system.

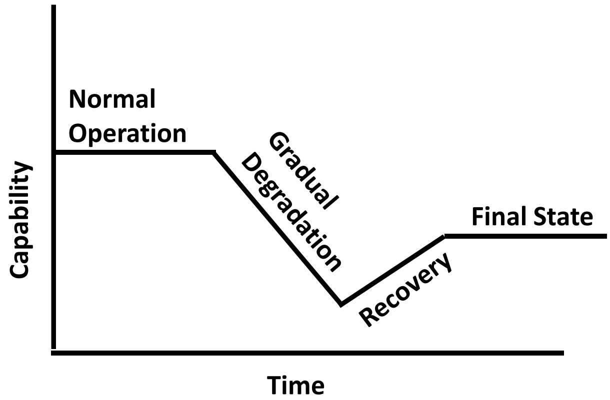


Figure 1: a typical timeline as it is often depicted in the literature.

Normal Operation

The resilience scenario begins with normal operations. In this phase the system will not have encountered an adversity. If the system encounters an adversity during this phase, the designer will want the system to continue in this condition following the encounter with the adversity. The system will do this if it can *withstand* the impact of the adversity. The system can do this if it has been designed with the appropriate amount of *absorption* capability as defined by Jackson and Ferris (2013). Following the encounter with the adversity, the system will remain in the operational mode showing that it is resilient to that adversity.

In the hurricane scenario, a quite common technique, called *absorption,* is to nail plywood to the frames of all glass widows to absorb the blows of debris flying in the wind. The design feature to achieve the absorption technique is the application of any element that will help the system *withstand* the adversity.

A second scenario is also possible in the normal operations mode. It is called the *heightened awareness* state. In this state, the system will have become aware of an approaching adversity. The system does this through an advanced detection capability it may have. A terrain avoidance warning system (TAWS) on an aircraft is an example. If the system does this it may be able to avoid the adversity entirely using the drift correction technique described by Jackson and Ferris (2013). The design feature to achieve early warning is any sort of electronic detection device. As described by Klemetti (2013), a device called AVOID (airborne volcanic object management detector) has been developed for detection of harmful levels of volcanic ash.

Gradual Degradation

Another variation on Normal Operations occurs when the system suffers some damage, leaving it partially damaged. In this case the system will begin to decline in capability until it reaches a lower level of sustained capability. The loss of one engine on an aircraft is an example. This is a common occurrence on a military aircraft in combat. The attribute that manages this decline in capability is called the tolerance attribute. The degree to which the system can decline in capability is determined by the system owner.

This decline in capability can occur either in the Normal Operations mode or the Heightened Awareness mode.

At the end of the Gradual Degradation, the system will find itself in the Partial Capability state. In this state the system can display its absorption capability to remain in its Partial Capability state if the system owner wishes.

Partial Capability State

Having achieved a partial capability state, the system has many opportunities. First, it can remain in that state if it wishes.

Second, it may encounter yet another adversity and degrade to yet another level of partial capability.

But most importantly, it may desire to recover to a complete level of Normal Operations. To do this, the system designer will need to design the system accordingly. There are several design techniques, but the most appropriate one is most likely the reconfiguration technique described by Jackson and Ferris (2013). The design feature to achieve reconfiguration would be a structure with many interconnected parts.

Recovery

Recovery is the transition to the end state desired by the system owner. It is not necessarily the Normal Operations state. This state may either be a Partial Capability state described above or the Normal Operations state that existed before the encounter with the adversity.

Recovery may be achieved through one or more of the techniques described by either Jackson and Ferris (2013) or (Brtis 2016) for the military domain. Typical techniques might include the *restructuring* technique.

In the case of US Airways Flight 1549 described by Pariès (2011), the entire aircraft was lost in the Hudson River. However, all 155 persons on board survived making this a successful Partial Recovery case and hence a resilience success.

Decommissioning

For cases for which the system is either destroyed or is in a non-functional state, the system owner, perhaps an airline, will want to decommission the system permanently. This was the case with the aircraft in the US Airways Flight 1549. Nevertheless, the system owner will want the system to enter this state in the gentlest possible way. The systems analyst will want to revisit the techniques that were useful in implementing the tolerance attribute before. The functional redundancy technique is typical.

In the case of Flight 1549, *functional redundancy* was achieved with the use of a RAM (ram air turbine) as a design feature to provide internal power to augment the primary power from the aircraft engines.

Evolution

As a final step, let us say the system owner wants to create a new system or a reconstituted system that would replace the decommissioned one. This would include revisiting all the attributes and techniques that were considered in the original system. It would also include revisiting the adversities to decide whether the original ones still apply or whether new ones need to be considered. As time goes on new disciplines will arise, such as cybersecurity. However, before a new system can be deployed, a complete resilience analysis is required. There is a basic principle that resilience must be built in and not added on.

Conclusions

As seen in the above example scenario, an engineered system has many ways to recover from the impact of an adversity. This example scenario has shown only a few of those for illustration. It is hoped that this article will encourage the reader to examine the concept of resilience in more depth.

References

Brtis, John. 2016. How to Think About Resilience in a DoD Context. Colorado Springs, Colorado USA: The MITRE Corporation.

Dori, Dov, and Hillary G. Sillitto. 2017. "What is a System? An Ontological Framework." *Systems Engineering* 20 (3):207-219.

Jackson, Scott, and Timothy Ferris. 2013. "Resilience Principles for Engineered Systems." *Systems Engineering* 16 (2):152-164.

Klemetti, Eric. 2013. "Can We Make Air Travel Safer from Volcanic Ash Hazards?" *Discover*,

November 14, 2013.

Madni, Azad,, and Scott Jackson. 2009. "Towards a conceptual framework for resilience engineering." *Institute of Electrical and Electronics Engineers (IEEE) Systems Journal* 3 (2):181-191.

Pariès, Jean. 2011. "Lessons from the Hudson." In *Resilience Engineering in Practice: A Guidebook*, edited by Erik Hollnagel, Jean Pariès, David D. Woods, and John Wreathhall, 9-27. Farnham, Surrey: Ashgate Publishing Limited.

A Guide to Building a More Resilient Business (*Harvard Business Review)*

Chaos and Resilience Engineering: Mental Models, Tools and Experiments

---

3.2 The Scientific Academy for Service Technology

(ServTech)

Potsdam, Germany

by

Professor Bernd Krämer

kraemer@servtech.info

ServTech is a non-profit research association based in Potsdam, Germany that was founded in 2007 to advance application-oriented scientific research, technological innovation, and technology diffusion in the areas of smart applications, big data, software engineering, service-oriented computing (SOC), and cloud computing. ServTech also acts as a research and technology consultant, e.g., to the German Federal Government in the context of the Annual National Digital Summit in the field Intelligent Education Networks. In addition, ServTech provides training and education services and organizes and sponsors scientific events. ServTech is the main sponsor of the prestigious International Conference on Service Oriented Computing series (www.icsoc.org) and sponsors the Symposium and Summer School On Service-Oriented Computing (SummerSOC - www.summersoc.eu), an annual summer school and symposium focusing on the research needs and training of young and upcoming researchers.

The ServTech team comprises well-known senior academics with long-standing industry ties who have long-term impact on international research demonstrated by seminal publications and funded by international scientific agencies including the EU (FP and H2020 programs), the US National Science Foundation (NSF), the Australian Research Council (ARC), the Deutsche Forschungsgemeinschaft (DFG), the Dutch Research Council (NWO) and other national research bodies. The ServTech team's key competences span areas including, but not limited to data integration and interoperability, software and service engineering, business processing, novel software architectures, smart platforms, cloud computing, IoT, smart manufacturing, smart healthcare, knowledge-based structures, and domain-specific languages for smart data systems and applications. ServTech's experts work at the forefront of R&D, they advise national research bodies and academic institutions, can influence the introduction or improvement of standards, and have strong ties with industry and public authorities.

Recent Project Work

Industry 4.0 (Smart Manufacturing)

ServTech participated in the EU Framework 7 Integrated Project IMAGINE (Innovative End-to-end Management of Dynamic Manufacturing Networks – https://portal.effra.eu/project/969#) as scientific coordinator. In this project, ServTech designed a federated IT platform supporting the Industry 4.0 shift from linear, sequential supply chain operations to an interconnected, open system of supply operations - known as a smart manufacturing network [1] – which lays the foundation for how manufacturers and suppliers can collaborate to produce a range of innovative digital products. In this project, ServTech also developed a framework comprising programmable abstract knowledge types that convey manufacturing knowledge - called manufacturing blueprint images (or simply blueprints) [1], [2]. These turn conventional products into self-describing products by storing, linking, combining, and analyzing the raw data collected by a product throughout its lifecycle and the processes that produce it. Manufacturing blueprints rely on model-based design techniques to manage and inter-link product data and information (both its content and context), product portfolios and product families, manufacturing assets (personnel, plant machinery and facilities, production line equipment), and, in general, help meet the requirements (functional, performance, quality, cost, time, etc.) of an entire manufacturing network. This information can be put within a broader operational context, providing the basis for manufacturing actionable "intelligence" and a move toward more fact-based decisions. In this way "smart actionable data" is created from which knowledge can be generated and production processes can be triggered.

In December 2019, ServTech concluded the EU Horizon 2020 project ICP4Life (An Integrated Collaborative Platform for Managing the Product-Service Engineering Lifecycle - www.icp4life.eu). In this project, the blueprint approach was extended to cover the needs of customized product-service systems by including IoT sensors and smart devices and putting those technologies to use on the manufacturing floor, collecting data to drive predictive analytics. In addition, ServTech developed a novel Product-oriented Configuration Language (PoCL) for customizing digital products [2], [3]. This is a user-centric language which provides 3D CAD/CAM interactive abilities to help customers collaborate with product designers and engineers exploring digital product and service configurations. PoCL supports:

- Digital product features framing: this feature supports different types of complex innovative shapes and helps streamline collaboration between stakeholders while checking the consistency and satisfaction of customer's requirements in-line with the customization process. The graphical language employs easily combinable graphical representations of 3D CAD product shapes and combines product quality characteristics with product design artefacts.

- Progressive product configuration sketching and wireframing: PoCL employs cross-functional teams, such as product engineers and service designers, which it engages with customers to create conceptual drawings for final assessment and approval to create a virtual product (viz. digital twin). Stakeholders identify relevant product requirements, can alter digital product prototypes quickly by managing the product parameters in a systematic manner, and estimate the cost and quality implications of potential design improvements.

Smart Healthcare

Currently, ServTech is active with partners in developing smart medical technologies in the context of the EU-funded Horizon 2020 project Monitoring Multidimensional Aspects of Quality of Life after Cancer Immuno-Therapy (QUALITOP - https://cordis.europa.eu/project/id/875171). The objective of this project is to design and develop a European digital smart medical platform that uses big data analytics, AI, and simulation modeling to collect and aggregate efficiently and effectively masses of quality of life data about patients who have undergone cancer Immuno-therapy treatment; monitor these patients' health status; conduct causal inference analyses; create harm-reduction recommendations for the patients; store, reuse and improve and disseminate medical findings. ServTech will develop a Smart Medical Platform and mechanisms to enable collecting and aggregating medical data to monitor health status and Quality of Life (QoL) of cancer patients after immunotherapy. This platform will operate on Smart Medical Data: a cohesive, organized, meaningful, and insightful collection of data from widely-spread medical sources including patient profile data, electronic medical records, vital signs (e.g. blood pressure, sodium levels, blood sugar levels, etc.), patient's medical history (diagnosis and prescriptions related data), medical and clinical data (for example, data from imaging and laboratory examinations), symptoms, tests, medication, psychological and psychosocial data, environmental and nutritional data, patient-generated data using sensors and wearables, and so on. To improve medical data interoperability, ServTech will develop a systematic medical representation and interoperability language that operates on smart medical data: an expressive FL-7 FHIR compliant meta-data language that will align heterogeneous medical data sources to support seamless interoperability, in a manner that surmounts vocabulary, structure, and semantic data inconsistencies to drive artificial intelligence and predictive analytics.

Finally, in the project SmarT SElf-CarE for the PRevention and ManagemEnt of ChRonic Diseases (STEERER), ServTech will develop with partners a Medical AI Platform that fuses Big Data management, an interoperability language and a Medical Data Lake - to enable networked medical agencies to share and exchange trusted and secure medical data - with innovative AI-driven personalized risk prediction, prevention, and intervention models that facilitate preventive care. The platform will connect patients and clinicians through a user-friendly smart interface and smartphone applications, delivering improvements in outcomes and cost while enabling added attention and resources to patients with higher acuity. It acts as an intelligent personal health assistant to:

1. Provide a personalized experience in which patients can ask questions and learn how to better manage their own health;

2. Understand disease progression in real time and characterize the status and health condition of each individual; and

3. Deliver active self-management support, personalized predictions and recommendations to strengthen prevention and improve outcomes for individuals in collaboration with medical professionals.

Contact

For more information about ServTech or possibilities for collaboration, please contact: Professor Bernd Krämer (kraemer@servtech.info) or Professor Mike Papazoglou (mikep@servtech.info).

References

[1] Papazoglou, M.P., van den Heuvel, W.J. and Mascolo, J.E. "A Reference Architecture and Knowledge-Based Structures for Smart Manufacturing Networks". *IEEE Software* May/June 2015, pp 61-69.

[2] Elgammal, A., Papazoglou, M.P., Krämer, B. J., and Constantinescu, C. "Design for Customization: A new paradigm for Product-Service System Development", 9th CIRP IPSS Conference on Circular Perspectives on Product/Service-Systems, 64, pp 345-350, 2017.

[3] Papazoglou, M.P., Elgammal, A., and Krämer B. J., "Collaborative On-Demand Product-Service Systems Customization", Lifecycle CIRP Journal of Manufacturing and Technology, Special Issue on New Research Advances on Product Service System along the Lifecycle, 2018, to appear. See: https://www.researchgate.net/publication/326632433_COLLABORATIVE_ON-DEMAND_PRODUCT-SERVICE_SYSTEMS_CUSTOMIZATION_LIFECYCLE

4. SYSTEMS ENGINEERING NEWS

4.1 Who is an Effective Systems Engineer?

Dr. Devanandham Henry of the Systems Engineering Research Center (SERC) and INCOSE India provided a Webinar on this topic on June 1, 2020. The presentation was based on the Helix Project and the Atlas Theory, and also referenced Wiley's 2018 book, *The Paradoxical Mindset of Systems Engineers*, by Arthur Physter, Nicole Hutchison, and Dr. Henry. Among several informative slides, one addressed the value delivered by systems engineers:

- Keep and maintain the systems vision.
- Translate technical jargon into business and operational terms.
- Enable diverse teams to develop systems.
- Manage emergence.
- Enable good technical decisions.
- Support the business case for the system.

Another interesting topic was examples of Atlas Theory in systems engineering being applied, for example, at the United States Army Research, Development, and Engineering Center (ARDEC), MITRE, Rockwell Collins, and Rolls Royce.

View Dr. Henry's Presentation on YouTube

4.2 Evolving Standards from Documents to Tools

Article by Eric Cosman

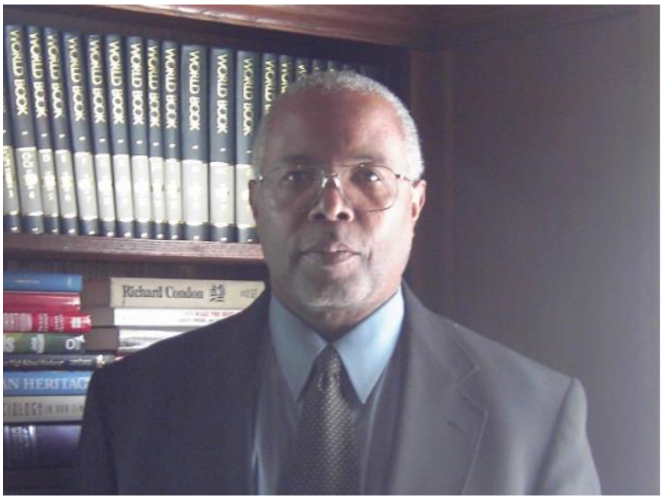
July, 2020

Article from the ARC Advisory Group Website

Standards Development Organizations (SDO's) must maintain or improve the specificity and quality of standards while finding ways to make their content more accessible, responsive to changing circumstances, and easier to apply. The essential purpose of engineering standards is to codify accepted and proven practice. Traditionally this has resulted in standards that can take years to develop and remain unchanged for several years. While this approach may work for many disciplines there are others that must be able to adapt and change much more rapidly. Examples include cybersecurity and smart devices.

We must ask ourselves whether current practices and methods are still sufficient to meet these changing needs. While a traditional standard document may be a useful reference source, we must find ways to turn it into a more active tool for use by those trying to apply the content. For example, in addition to publishing the usual document, what if an SDO were to deliver the content in the form of an online portal to a database that would allow interactive navigation of the content?

4.3 Passing of Professor Emeritus Arthur Sanderson Paul



Professor Arthur Sanderson Paul, professor emeritus in the Department of Computer Science served at Howard University for over 38 years as a faculty member in the College of Engineering, Architecture, and Computer Science. After graduating from Presentation Brothers College in St. George's, Grenada, Arthur Paul attended Howard University where he majored in Mechanical Engineering. Professor Paul was the first student to be awarded a graduate scholarship from the School of Engineering at Howard University for a new interdisciplinary graduate program in Urban Systems Engineering. After completing the Master of Science degree in Urban Systems Engineering in 1974, he was awarded a fellowship to a newly established PhD program in Systems Engineering at the University of Virginia. While pursuing his Ph.D., Dr. Paul consulted for the US Army Corps of Engineers, as well as, served in a part time capacity on the faculty at Howard University in the Mechanical Engineering and Urban Systems Engineering Departments within the School of Engineering, and the Department of Information Systems within the School of Business.

In 1981, Dr. Arthur Paul began a tenure-track appointment as an assistant professor in Urban Systems Engineering at Howard University. Dr. Paul was a catalyst in the development of the Systems and Computer Science program, the first accredited Computer Science program at an HBCU in the nation. During his 38 years at Howard University, Dr. Paul rose through the ranks to achieve the status of full professor with tenure in the Department of Systems and Computer Science. He also served as Interim Associate Provost for Research, during a time when the university was reorganizing the complex process of managing external grants and contracts, while maintaining compliance. Dr. Paul was also a co-founder of the Analysis Group, Inc., a Washington, DC based consulting firm that would receive prestigious national awards such as: Small Business Prime Contractor of the Year, and Minority Business Enterprise of the Year in 1986 and 1987. Dr. Paul was an active member of the International Council on Systems Engineering (INCOSE), the Sigma Xi Honorary Research Society, and the Grenada Cultural and Social Association.

From all who knew him, Dr. Arthur Sanderson Paul was a brilliant individual, a humble personality, a good man, and a great friend. The university will plan on celebrating Dr. Paul's life, as a community, when it is safe and appropriate.

4.4 Call for Papers: 4th International Conference Complex Systems Design & Management Conference (CSD&M) - Asia

Mastering complex engineered systems is a fundamental strategic challenge. Complex Systems Design & Management (CSD&M) conference is a widely open meeting event dedicated to academic researchers, industrial and governmental actors who are interested in complex industrial systems engineering.

The CSD&M conference was created in France and is currently organized each year in Paris since 2010 by the French non-profit organization CESAMES under the guidance & with the support of the « Complex Systems Engineering » industrial chair of Ecole Polytechnique (about 425 participants). It was then extended to the Asia-Pacific area: the Complex Systems Design & Management Asia (CSD&M Asia) conference was therefore organized each two year in Singapore since 2014 (about 450 participants, on the keynote themes: Smart Cities, Smart Nations and Smart Transportation).

Hosted by CSAA and organized by CESAMES, the 4th CSDM Asia edition will be held in Beijing by April 12-13, 2021 during two days. We sincerely thank you for the precious support and interest, and invite you to join again this academical institutional industrial meeting

The Call for Papers is open

All authors must submit their papers through our electronic submission system before the deadline. No other submission process will be accepted. They can, as mentioned previously, submit their paper as a 12-page Word or LaTex or in a 15-slide PowerPoint. The maximum number of pages has to be adhered to.

The accepted papers (full or abstract) will be included into CSD&M Asia 2020 Conference Proceedings, which will be published in the Advances in Intelligent Systems and Computing Series by Springer Verlag, which will be archived in the DBLP, Scopus and indexed by EI Compendex and ISI Clarivate. Authors of the accepted full papers will report during the Parallel Sessions while those of the abstracts accepted will present at the Posters Session of the conference.

View the list of topics here.

4.5 Job Opportunity: Powertrain Systems Engineering Practitioner

LHP Engineering Solutions is growing and is looking for a Powertrain Systems Engineering Practioner to work in the greater Detroit area with 4+ years of experience. Must have experience with SysML modeling with Magic Draw (Preferred) or Visio. Please reach out if you are interested in learning more. joe.skowronek@lhpes.com.

4.6 INCOSE ASEC 2020 is Going Virtual

INCOSE UK has just announced that the INCOSE ASEC 2020 will be held virtually. The physical conference was due to take place from 19-21 November – follow INCOSE UK's LinkedIn page for further details to be announced soon.

4.7 Vitech Blog Post: Controlling the Complex Adaptive System

July 30, 2020

From the Vitech Community page

Complex adaptive systems can be described as an arrangement of individual elements (called "agents" in the study of complexity) with freedom to act in ways that are not necessarily predictable. The actions of the system agents impact the system context for other elements. That means that the agents "learn" to adapt based on their interactions with the other agents of the systems. There is little chance that the complex adaptive system will reach an equilibrium state where the agents cease to adapt. This makes it extremely hard to predict, much less control, the emergent system behavior.

Read the full article here.

4.8 SESA National Speakers Event 25 August 2020

Autonomous Road Transport – A Systems Approach

In the next Systems Engineering Society of Australia Event, the topic of autonomous vehicles will be addressed. Autonomous Vehicles (AV) and driverless cars is a consistent trending topic that has grown over the past decade. With the advancement in available technology, the concept of AV's and the road to implementation is accelerating faster than the society and regulations of which is required to introduce it. This immediately becomes a challenge for engineers as several industries struggle to implement the technology in such a complex environment. Oversaturation of information is also a noted issue, namely found in science fiction and media which further dilutes the effort and mission. Speakers for the event around this complex topic are:

- John Wall (Program Manager, Future Vehicles and Technology | Austroads)
- Greg Giraud (Managing Director | EasyMile Australia & NZ)
- Miranda Blogg (Director | Cooperative and Automated Vehicle Initiative (CAVI))
- Jon Sciortino (Senior Systems Engineer | Nova Systems))

and host

- Rita Excell (Executive Director | Australia and New Zealand Driverless Vehicle Initiative (ADVI))

Register for the conference now

4.9 Call for Presentations and Training Workshops for the 2nd Annual INCOSE New England Fall Workshop

This year's virtual workshop will have tracks in both Model Based Systems Engineering and System Architecture. Virtual Cafes will be open during the conference to facilitate participant interchanges on the breaks between sessions.

Topics of Interest include:

- Model Based Systems Engineering (MBSE)
- MBSE Practical Applications
- Modeling System Attributes
- Integration of Models and Tools
- Model Validation Techniques
- Modeling and Simulation of Complex Systems
- Domain Specific Modeling Techniques System Architecture (SA)
- System Architecture and Architectural Frameworks
- Applied System Thinking
- Architecting Complex Systems of Systems
- Architecture Considerations for Human Machine Interfaces
- Automation in System Architectures
- Architecting Resilient Systems

More Information

5. FEATURED ORGANIZATIONS

5.1 Digital Twin Consortium

Digital Twin Consortium is a program of Object Management Group dedicated to the widespread adoption of digital twin technology and the value it delivers. Object Management Group (OMG) has built and managed programs for over 30 years. OMG invites companies to become founding members who will oversee the creation and growth of the program. Through cross-industry collaboration, the Consortium will help enterprises maximize the benefits of digital twin technology – sharing within a member ecosystem the lessons learned and opportunities uncovered within the virtual world and applying them to the physical world.

Digital Twin Consortium recognizes the need for technology standards in digital twin innovation but will not develop standards. It will influence standards by deriving requirements that will be submitted to international standards' development organizations, such as Object Management Group and ISO/IEC.

Mission

Digital Twin Consortium drives the adoption, use, interoperability, and development of digital twin technology. It propels the innovation of digital twin technology through consistent approaches and open source development. It is committed to accelerating the market and guiding outcomes for users.

Vision

The goal of the consortium is to be The Authority in Digital Twin as it relates to policy, security, interoperability, and overall development of digital twins. The consortium will define the ecosystem, standards requirements, architectures, open source code, identify gaps, and publish statements and opinions. This will be done in partnership between industry, academia, and government in a collaborative open environment.

More Information

Membership Information

5.2 Cynefin Centre for the Application of Complexity

Bangor University, UK

Empirical research conducted by the Cynefin Centre tests and refines the Cynefin model of complexity. Complexity theory is the science of uncertainty, of understanding how to interact with multiple actors in multiple contexts. It represents a radical new paradigm in thinking of the relevance for governments and industry alike. The Cynefin Centre uniquely focuses on real world engagement in programs that are consistent with scientific theory but which seek to change the way we live and work for the better, creating new approaches to innovation, and peer to peer knowledge flow and engagement.

More Information

5.3 Sigma Theta Mu Association

The Sigma Theta Mu Association was founded at the 25th Annual International Symposium of the International Council on Systems Engineering (2015, Seattle Washington USA). It was established by the Founding Board of INCOSE to mark in a fitting manner those who have conferred honor upon their Alma Mater by distinguished scholarship in the study of systems or in the field of systems engineering.

More Information

5.4 American Society of Mechanical Engineers (ASME)

ASME is a not-for-profit membership organization that enables collaboration, knowledge sharing, career enrichment, and skills development across all engineering disciplines, toward a goal of helping the global engineering community develop solutions to benefit lives and livelihoods. Founded in 1880 by a small group of leading industrialists, ASME has grown through the decades to include more than 100,000 members in 140+ countries. Thirty-two thousand of these members are students.

From college students and early-career engineers to project managers, corporate executives, researchers and academic leaders, ASME's members are as diverse as the engineering community itself. ASME serves this wide-ranging technical community through quality programs in continuing education, training and professional development, codes and standards, research, conferences and publications, government relations and other forms of outreach.

More Information

5.5 Netherlands Organization for Scientific Research

The Dutch Research Council (Dutch: Nederlandse Organisatie voor Wetenschappelijk Onderzoek) is the national research council of the Netherlands. NWO funds thousands of top researchers at universities and institutes and steers the course of Dutch science by means of subsidies and research programs. NWO promotes quality and innovation in science. NWO is an independent administrative body under the auspices of the Dutch Ministry of Education, Culture, and Science. NWO directs its approximate budget of 1 billion euros towards Dutch universities and institutes, often on a project basis. Also, NWO has its own research institutes and facilitates international cooperation.

Source: Wikipedia

6. NEWS ON SOFTWARE TOOLS SUPPORTING SYSTEMS ENGINEERING

6.1 Innoslate 4.3 Released to the Cloud

SPEC Innovations has announced the release of 4.3 of its flagship tool - Innoslate Cloud.

Below are some of the new features in 4.3. View the release notes.

- Interface Control Diagram (ICD)
- Risk Burndown Chart
- ReqIF Import and Export
- OAUTH/SAML/HSPD–12(PKI) Support
- Acronym Extractor
- Activity Feed Report

Read more

6.2 Sparx Systems Announces Enterprise Architect 15.2 Beta

A new release of Enterprise Architect expands on collaborative and mathematical capability of the tool.

New features:

- Enhanced views in the Inspector window
- A new Chart API and built in JavaScript support
- Dashboard diagrams automatically lay out charts (and other elements) in a selectable grid
- The Google and AWS icon libraries are updated

From the website:

“Version 15.2 introduces new windows, new behavior and improved ways of maximizing your modeling time. New tools such as the Focus window take you back into the model and keep you in touch with recent developments. Old favorites such as the Element Browser have been given a fresh new look and location.”

Read more

---

7. SYSTEMS ENGINEERING PUBLICATIONS

7.1 Worldwide Directory of Systems Engineering & Industrial Engineering Academic Programs

INCOSE and the Systems Engineering Research Center (SERC) at Stevens Institute of Technology collaborate to provide a Worldwide Directory of Systems Engineering and Industrial Engineering Academic Programs. The third edition (2017) of the Directory is available for download.

The information provided in the Directory is primarily drawn from university websites, with verification or updates from faculty included as much as possible. For each university with systems and industrial engineering offerings, the following information is provided: the name and address of the university; the specific degrees the university offers (e.g., a B.S. in Systems Engineering or a Ph.D. in Industrial Engineering); the academic unit that offers these degrees; the head of the academic unit offering these degrees; and a URL where more information can be found.

This is the third edition of the Directory, reflecting numerous updates since the first edition was released in early 2015. With each new edition, we want to correct any errors identified by the community, incorporate new programs, and add any programs we may have inadvertently omitted. In addition to a limited number of printed copies, the directory is posted online at both the INCOSE (https://www.incose.org/) and the SERC (https://sercuarc.org/worldwide-directory/) websites to enable broad distribution.

There were challenges in deciding which programs to include, as there are many variations in how universities name their systems and industrial engineering programs, especially when looking globally.

With a few exceptions, only programs with the title “Systems Engineering,” “Industrial Engineering,” or programs that combine other fields with these, such as “Operations Research and Systems Engineering.” Generally, programs targeted to a specific domain or technology, such as “Computer Systems Engineering” or programs which involved more business-focused courses such as “Engineering Management” were not included.

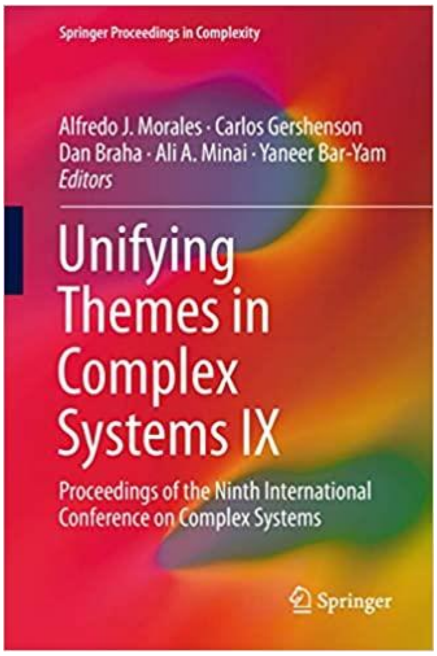
Download the Directory

Submit updates or corrections to: ISEDirectory@stevens.edu.

7.2 Unifying Themes in Complex Systems IX: Proceedings of the Ninth International Conference on Complex Systems

edited by

by Alfredo J. Morales, Carlos Gershenson, Dan Braha, Ali A. Minai and Yaneer Bar-Yam



From the Amazon.com Website:

Unifying Themes in Complex Systems is a well-established series of carefully edited conference proceedings that serve to document and archive the progress made regarding cross-fertilization in this field. The International Conference on Complex Systems (ICCS) creates a unique atmosphere for scientists from all fields, engineers, physicians, executives, and a host of other professionals, allowing them to explore common themes and applications of complex systems science. With this new volume, Unifying Themes in Complex Systems continues to establish common ground between the wide-ranging domains of complex systems science.

Publisher: Springer; 1st ed. 2018 edition (July 25, 2018)

Format: Kindle, Hardcover, Paperback

ISBN-10: 331996660X

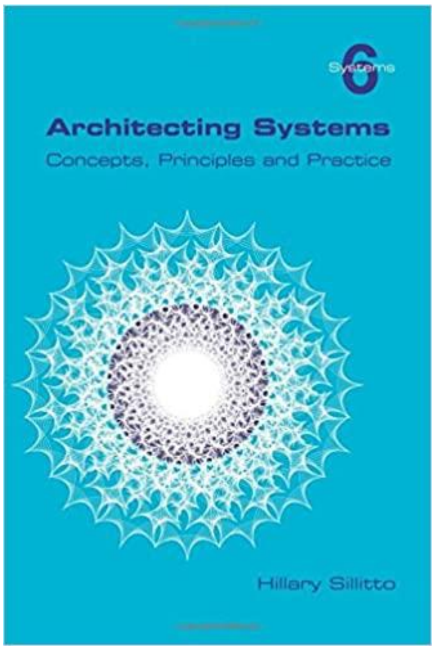
ISBN-13: 978-3319966601

More Information

7.3 Architecting Systems - Concepts, Principles, and Practice

by

Hillary Sillitto



From the Amazon.com Website:

What do the Wall Street "Flash Crash", the 2003 invasion of Iraq, and the community on the remote Scottish island of St Kilda, have in common? They're all complex systems that failed in unexpected ways because critical interdependencies weren't understood properly. Why do so many big projects overspend and over-run? They're managed as if they were merely complicated when in fact they are complex. They're planned as if everything was known at the start when in fact they involve high levels of uncertainty and risk. In a rapidly changing world, how do you plan for success and create adaptable, resilient, sustainable systems that will achieve their purpose without adverse unintended consequences? Based on the author's extensive experience as a practical engineer and thought-leader in the systems business, this book provides a highly readable synthesis of the foundations for architecting systems. Starting from a clear set of systems principles and insights into the nature of complexity, the "six step architecting process" will help you to unravel complexity and to architect systems of any type, scale and socio-technical mix. It's illustrated with numerous examples ranging from familiar domestic situations through software-dependent products and services to ultra-large-scale sociotechnical networks spanning the planet. This book is required reading for engineers, managers, clients and leaders of change faced with the challenges of developing systems for the 21st Century. It gives architecting teams and their stakeholders a common understanding of the why, the what, and the how of architecting systems fit for the future. Topics covered include: system architecture, complex systems, and complexity.

Publisher: College Publications (2014)

Format: Paperback

ISBN-10: 1848901542

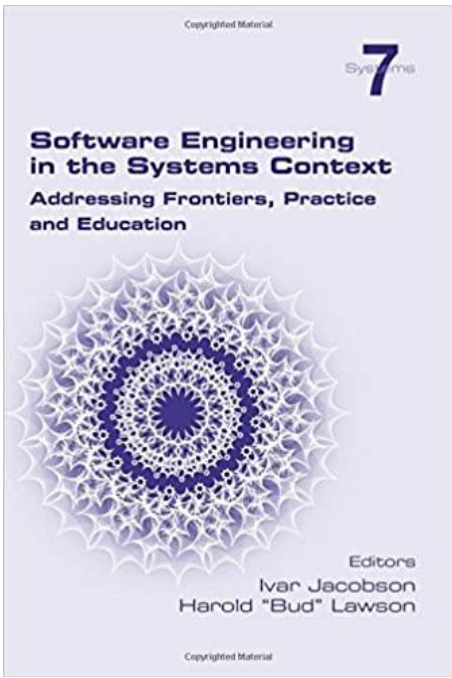
ISBN-13: 978-1848901544

More Information

7.4 Software Engineering in the Systems Context: Addressing Frontiers, Practice, and Education

editors by

Ivar Jacobson and Harold Bud Lawson



From the Amazon.com Website:

This book has been created to provide various perspectives concerning the problems and opportunities presented by the increasing central role of software in the world's systems. In particular, the role of and relationship between Software Engineering and Systems Engineering in the provisioning of software systems and their integration into system environments. The perspectives shed light on such aspects as driving concepts and principles, guidance on selecting development approaches, issues of complexity, stakeholder concerns and requirements, the vital role of architecture, agility, governance, resilience, trust, risk, acquisition, supply chains, technical debt, socio-technical aspects, standards, as well as the fundamental aspects of improving communication and understanding. Of particular importance is the presentation of OMG Essence Kernel and its utilization that are aimed at re-founding Software Engineering. In order to deal with software in the systems context, ideas for providing a complementary Systems Engineering Essence are introduced and a Call to Action to work on this endeavor is issued. The endeavor will lead to a new level of understanding and communication amongst Software and Systems Engineers and provide a common basis for constructing their methods and practices based upon the application of the Kernel. The editors are pleased to be able to present the perspectives of international experts on the issues related to unifying Software and Systems Engineering, including Ilia Bider, Barry Boehm, Lindsey Brodie, Francois Coallier, Tom Gilb, Rich Hilliard, Ivar Jacobson, Harold “Bud” Lawson, Anatoly Levenchuk, Svante Lidman, Paul E. McMahon, Moacyr de Mello, Barry Myburgh, Pan-Wei Ng, Don O’Neill, June Sung Park, Sarah Sheard, Ian Sommerville, and Ian Spence.

Following is a review of the book from the Amazon.com Website:

The title describes the content perfectly - an anthology of articles by expert contributors representing the who's who in both disciplines. This book is the perfect blending and contains relevant content for practitioners, management, and systems acquisition professionals. Conveniently grouped, Part 1 provides essential background and important concepts that establish the systems context and should be read by all. OMG's Essence Kernel is the focus of Part 2, which contains interesting discussions about harmonizing CMMI and agile methods, and systems/software alignment according to the ISO/IEC/IEEE 15288 standard. Finally, Part 3 takes up major themes surrounding requirements and risk management, and supply chain coordination practices. Examples throughout the book touch on global grand challenges.

Publisher: College Publications (2015)

Format: Paperback

ISBN-10: 1848901763

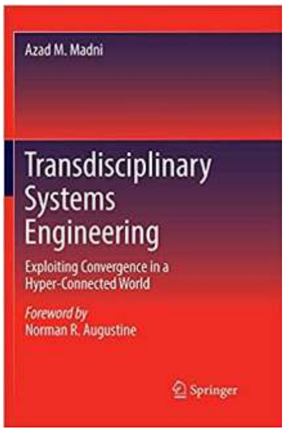
ISBN-13: 978-1848901766

More Information

7.5 Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-Connected World

by

Azad M. Madni



From the Amazon.com Website:

This book explores the ways that disciplinary convergence and technological advance are transforming systems engineering to address gaps in complex systems engineering: Transdisciplinary Systems Engineering (TSE). TSE reaches beyond traditional disciplines to find connections—and this book examines a range of new methods from across such disparate areas of scholarship as computer science, social science, human studies, and systems design to reveal patterns, efficiencies, affordances, and pathways to intuitive design. Organized to serve multiple constituencies, the book stands as an ideal textbook supplement for graduate courses in systems engineering, a reference text for program managers and practicing engineers in all industries, and a primary source for researchers engaged in multidisciplinary research in systems engineering and design.

Publisher: Springer; Softcover reprint of the original 1st ed. 2018 edition (August 26, 2018)

Format: Paperback

ISBN-10: 3319872508

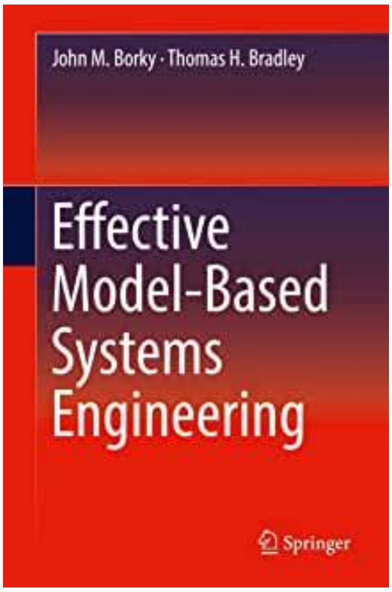
ISBN-13: 978-3319872506

More Information

7.6 Effective Model-Based Systems Engineering

by

John M. Borky and Thomas H. Bradley



From the Amazon.com Website:

This textbook presents a proven, mature Model-Based Systems Engineering (MBSE) methodology that has delivered success in a wide range of system and enterprise programs. The authors introduce MBSE as the state of the practice in the vital Systems Engineering discipline that manages complexity and integrates technologies and design approaches to achieve effective, affordable, and balanced system solutions to the needs of a customer organization and its personnel.

The book begins with a summary of the background and nature of MBSE. It summarizes the theory behind Object-Oriented Design applied to complex system architectures. It then walks through the phases of the MBSE methodology, using system examples to illustrate key points. Subsequent chapters broaden the application of MBSE in Service-Oriented Architectures (SOA), real-time systems, cybersecurity, networked enterprises, system simulations, and prototyping. The vital subject of system and architecture governance completes the discussion. The book features exercises at the end of each chapter intended to help readers/students focus on key points, as well as extensive appendices that furnish additional detail in particular areas. The self-contained text is ideal for students in a range of courses in systems architecture and MBSE as well as for practitioners seeking a highly practical presentation of MBSE principles and techniques.

Publisher: Springer; 1st ed. 2019 edition (September 9, 2018)

Format: eTextbook, Hardcover, Paperback

ISBN-10: 331995668X

ISBN-13: 978-3319956688

More Information

7.7 INCOSE *INSIGHT* Practitioners Magazine

Volume 23, Number 2

***INSIGHT's* mission** is to provide informative articles on advancing the state of the practice of systems engineering. The intent is to accelerate the dissemination of knowledge to close the gap between the state of practice and the state of research as captured in Systems Engineering, the Journal of INCOSE, also published by Wiley. INCOSE thanks corporate advisory board (CAB) member Lockheed Martin for sponsoring *INSIGHT* in 2020 and welcomes additional sponsors, who may contact the INCOSE director for marketing and communications at marcom@incose.org.

The June 2020 issue of *INSIGHT* is a follow-up to the December 2016 publication, addressing *Critical Infrastructure Protection and Recovery*. The authors committed to this topic over a year ago and the publication now is unintentionally timely as we are amid a global pandemic from the novel coronavirus COVID-19 that has demonstrated the fragility of our closely coupled global infrastructure.

INCOSE thanks theme editor Mitchell Kerman and the authors for sharing their contributions with the larger community. The theme of this issue represents the work of the INCOSE Critical Infrastructure Protection and Recovery (CIPR) Working Group with chair Daniel Eisenberg and co-chairs John Juhasz and Anthony Adebonojo. The purpose of the working group is to provide a forum for the application, development, and dissemination of systems engineering principles, practices, and solutions relating to critical infrastructure protection and recovery against manmade and natural events causing physical infrastructure system disruption for periods of a month or more.

Critical infrastructures provide essential services underpinning modern societies. These infrastructures are networks forming a tightly coupled complex system cutting across multiple domains. They affect one another even if not physically connected. They are vulnerable to manufactured and natural events that can cause disruption for extended periods, resulting in societal disruptions and loss of life. The inability of critical infrastructures to withstand and recover from catastrophic events is a well-documented global issue. This is a complex systems problem needing immediate coordinated attention across traditional domain and governmental boundaries.

The lead article, "Toward Building a Failsafe Hospital: The Impending Drug Resistant Pandemic," by Josh Sparber, was written before the current pandemic. Josh writes that an adverse circumstance with immense potential for harm is the growing scourge of pandemics, specifically, those caused by drug-resistant microbial organisms. Systems engineers can use lean agile methods, incorporating the concept of antifragility to design systems responsive to reducing pandemic threats. The articles in the current issue are as follows:

1. Toward Building a Failsafe Hospital: The Impending Drug Resistant Pandemic.
2. Systems Theory Principles and Complex Systems Engineering Concepts for Protection and Resilience in Critical Infrastructure: Lessons from the Nuclear Sector.
3. Use of SysML to Generate Failure Modes and Effects Analyses for Microgrid Control Systems.
4. Microgrids — A Watershed Moment.
5. Defining Critical Communications Networks: Modelling Networks as Systems.
6. Emergency Systems and Power Outage Restoration Due to Infrastructure Damage from Major Floods and Disasters.
7. Loss of Offsite Power Recovery Modeling in United States Nuclear Power Plants.

Instructions for Viewing:

The entire issue of *INSIGHT* Volume 23, No. 2 is now available for viewing in the INCOSE Connect Library INSIGHT Practitioners Magazine.

INSIGHT Volume 23 No. 2 will be available later on the Wiley Online Library and you will be notified in a separate announcement when it is available.

Concerning future issues, the remaining 2020 *INSIGHT* themes and articles are already committed as well as those for 2021. The editors of *INSIGHT* would be pleased to accept proposals from INCOSE chapters, working groups, and affiliated bodies for themed issues centered on systems engineering practices in 2022.

8. EDUCATION AND ACADEMIA

8.1 Master's in Intelligent Engineering Systems - Izmir University of Economics, Turkey

In an increasingly competitive world where more and more data is becoming available from web documents, digital media, financial markets, and wireless sensors, there is a great need for new intelligent systems that can analyze the huge amounts of data and make the right decisions.

These intelligent systems can analyze the stock markets and make robust predictions, control and optimize factory productions in an uncertain environment, improve transportation safety, improve the quality of life of the elderly or entertain the children. IEU's 2-year Master program on Intelligent Engineering Systems with Thesis is composed of three tracks: Intelligent Computing Systems, Intelligent Software Systems, and Intelligent Production Systems. The Master programme offers to students a wide range of courses that provide a solid theoretical foundation, a set of practical tools and projects that allow the understanding and the design of intelligent systems and services that fulfill the needs for a dynamic and ever-changing industry and offer exciting opportunities for research.

Read more

8.2 Rensselaer Polytechnic Systems Engineering and Technology Management (SETM)

Troy, New York

The School of Engineering and the Lally School of Management at Rensselaer jointly offer a unique 30 credit hour Master of Engineering (ME) degree in Systems Engineering and Technology Management (SETM) administered through the Industrial and Systems Engineering Department (ISE). The degree is for applicants with an undergraduate engineering degree in any discipline who have a desire to extend their understanding of emerging technologies within their discipline and provide a fundamental background in technical decision-making methods and technology management. The unique feature of this program is the fusion of a management/decision sciences core with the student's undergraduate engineering discipline.

This 30-credit-hour program leading to the Master of Engineering degree is open to qualified engineering graduates from any institution. The principle target applicant pool is class year Rensselaer seniors from all undergraduate engineering disciplines who desire to complete a master's degree immediately following completion of the bachelor's degree.

Read more

9. SOME SYSTEMS ENGINEERING-RELEVANT WEBSITES

Open Access in the Netherlands

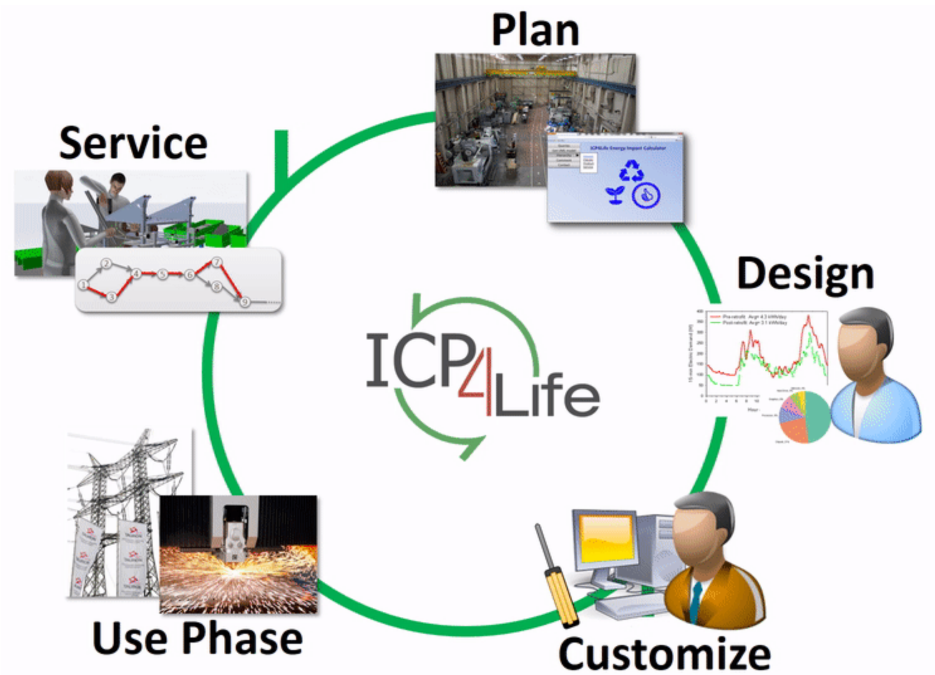
Scholarly communication of the Netherlands published in open access form can be found by searching the National Academic Research and Collaborations Information System (NARCIS). The web portal was developed in 2004 by the Data Archiving and Networked Services of the Netherlands Organization for Scientific Research and the Royal Netherlands Academy of Arts and Sciences. The Dutch government has voiced the ambition that by 2019, 60% of all publications from Dutch research universities should be published as open access, and by 2024 this should be 100%. The Society of Dutch Universities is negotiating deals with publishers, where open access publication for Dutch corresponding authors is free of additional charge. There are some 36 collections of scholarship in the Netherlands housed in digital open access repositories.

https://research.ou.nl/

ICP4LIFE – An Integrated Collaborative Platform for Managing the Product-Service Engineering Lifecycle

The European manufacturing industry faces new challenges, which are currently not addressed by today's products and systems. Most of the products are still in essence 'simple' in nature, with no capability for adapting to the consumers' needs and no integrated methods exist for the holistic acquisition and processing of feedback information emanating from product-services.

ICP4Life proposes an integrated, collaborative platform for the design, development and support of product-service systems for SMEs, equipment manufacturers and energy suppliers in order to maximize the impact in the European industry.



http://www.icp4life.eu/project/

10. STANDARDS AND GUIDES

10.1 ISO 62304 Medical Device Software – Software Life Cycle Processes

The international standard IEC 62304 – medical device software – software life cycle processes is a standard which specifies life cycle requirements for the development of medical software and software within medical devices. It is harmonized by the European Union (EU) and the United States (US), and therefore can be used as a benchmark to comply with regulatory requirements from both these markets. The IEC 62304 standard calls out certain cautions on using software, particularly SOUP (software of unknown pedigree or provenance). The standard spells out a risk-based decision model on when the use of SOUP is acceptable, and defines testing requirements for SOUP to support a rationale on why such software should be used.

Wikipedia

10.2 IEEE Software & Systems Engineering Standards Committee

The IEEE Software & Systems Engineering Standards Committee (S2ESC) is chartered by the IEEE Computer Society Standards Activities Board to codify the norms of professional software engineering practices into standards, including the standardization of processes, products, resources, notations, methods, nomenclatures, techniques, and solutions for the engineering of software and systems dependent on software.

S2ESC promotes the use of software engineering standards among clients, practitioners, and educators. S2ESC harmonizes national and international software engineering standards development and promotes the discipline and professionalization of software engineering. S2ESC also promotes the coordination with other IEEE initiatives.

Officers

- Edward Addy, Chair
- Carl Singer, Vice-Chair
- Lynn Robert Carter, Secretary

More Information

To order a standard

Information Concerning a Standard and its Status

Latest Standards-related Products and Services

11. SOME DEFINITIONS TO CLOSE ON

Digital Transformation

Digital Transformation is the use of new, fast, and frequently changing digital technology to solve problems. It is about transforming processes that were non-digital or manual to digital processes. One of the examples of digital transformation is cloud computing.

Source: Wikipedia

Digital Twin

A digital twin is a digital representation of a physical object or system. The technology behind digital twins has expanded to include large items such as buildings, factories and even cities, and some have said people and processes can have digital twins, expanding the concept even further. The idea first arose at NASA: full-scale mockups of early space capsules, used on the ground to mirror and diagnose problems in orbit, eventually gave way to fully digital simulations.

Source: Networkworld

The **Cynefin framework** (/kəˈnɛvɪn/ *kuh-NEV-in*) is a conceptual framework used to aid decision-making. Created in 1999 by Dave Snowden when he worked for IBM Global Services, it has been described as a "sense-making device". *Cynefin* is a Welsh word for *habitat*.

Cynefin offers five decision-making contexts or "domains"—*obvious* (known until 2014 as *simple*, more recently renamed to *clear* by Snowden), *complicated*, *complex*, *chaotic*, and *disorder*—that help managers to identify how they perceive situations and make sense of their own and other people's behavior. The framework draws on research into systems theory, complexity theory, network theory, and learning theories.

Source: Wikipedia

12. CONFERENCES AND MEETINGS

For more information on systems engineering related conferences and meetings, please go to our website.

The featured event for this edition is:

INCOSE Western States Regional Conference (Virtual Conference) September 17-19, 2020

The INCOSE Western States Regional Conference (WSRC) was begun in 2018 to become an annual regional-level INCOSE conference for the INCOSE chapters of the western United States (USA). WSRC was modeled after the Regional Mini-Conference 2016 and the many successful Great Lakes Regional Conferences (GLRC). WSRC provides a high-quality source of education and networking among and beyond INCOSE membership. The first WSRC in 2018 was attended by 120 people from 16 states with four SE PDD locations.

The WSRC is hosted by one chapter from among the Western United States INCOSE chapters region of the America's Sector of INCOSE with participation from the other western states chapters. The 11 chapters are shown below.

The WSRC 2020 includes the following critical domains:

- Healthcare and Medical Devices
- Critical Infrastructure: Communications, Energy, and Transportation
- Aerospace Systems
- DevOps, Agile, Information Security, HIS
- Model Based Systems Engineering (MBSE)
- Education and Workforce Development

PPI is proud to be participating in this conference as a sponsor. We encourage you to discover more or register for the conference here.

---

13. PPI AND CTI NEWS

13.1 VIDEO: PPI Launches A New Course: Interface Engineering and Management (IEM) Two Day Course

"Interfaces are the most common source of problems experienced in system integration. The good news is that most of these problems can be avoided. Learn how with PPI's new Interface Engineering & Management Two Day or four half-day Course, delivered by Paul Davies, author of "Don't Panic! The Absolute Beginner's Guide to Managing Interfaces".

Abstract:

Every interface is an opportunity to lose information, time, control and/or money through error or contention between stakeholders at each end. There are many issues surrounding interface engineering and management, which are relatively unexplored in the engineering literature. This is surprising, since integration across interfaces is nearly always a source of delays, missing functionality or poor performance in the introduction of new systems.

This course, over two days or four half-days, is simple enough to give anyone with good common sense and a modicum of technical knowledge and engineering practice a clear understanding of how to approach the definition and management of interfaces. Eight best practices are fully explained, and illustrated to give delegates the opportunity to use for themselves. These practices are exploited by leading enterprises, often without formal documentation, to give competitive advantage.

A useful set of templates and guidelines for writing interface specification documents is also included, as “handouts” and as an online resource.

The first course is taking place over four half-days from 2-5 November at:

- Europe UTC +1:00 (CET 13:30)
- North America UTC -5:00 (EST 7:30)
- North America UTC -7:00 (MST 5:30)
- Turkey UTC +3:00 (TRT 15:30)

Watch the introductory video where Paul Davies defines sets the scene and explains why we should be concerned about IEM and what you can expect from the course, here.

Find out more here.

13.2 Medical Device Risk Management: Now Offered Through Five Convenient Half-Day Sessions

PPI is pleased to share that our popular Medical Device Risk Management Course, delivered by BIjan Elahi, is now offered over five half-days instead of two and a half full days.

The course commences with the fundamentals of medical devices risk management, then builds upon the fundamentals, and teaches a practical, sensible and efficient way of performing medical devices risk management. The course includes multiple quizzes and hands-on workshops to deepen the learning, and create an engaging learning experience. Topics such as medical device software risk management, benefit-risk analysis and complaint handling are also addressed in this course.

This course will benefit:

- Practitioners of medical devices risk management– including systems risk managers, systems engineers, design engineers, manufacturing engineers, quality engineers, usability engineers.
- Evaluators of medical devices risk management– including quality assurance, management, regulatory staff.
- People with a need for general understanding of medical devices risk management– including clinical, marketing, packaging, toxicology, management.

Participants will not need prior knowledge or experience with medical device risk management, but experience in medical device development would be an advantage.

Register here for one of our upcoming courses taking place in November 2020 here.

13.3 PPI Webinar on Wedge Model™ Now Live on YouTube

On the 24th of July, PPI's Managing Director, Robert Halligan presented a 60-minute webinar on PPI's Wedge Model™, an evolved model of the well-known Vee Model. The Wedge Model™ shows the products of design on the left-hand side of the wedge, and the products of system integration on the right-hand side, with a second time axis showing multiple builds, such as for Agile development, coming out of the screen. Subjects of and references for verification and validation are superimposed. Verification answers the question "is the work product correct with respect to the inputs used to create it - usually meets requirements?" Validation asks, "is the work product what is needed?". Colloquially, verification is - have we done the job right, and validation is - have we done the right job?

Thank you to everyone that tuned in, we hope to see you at the next one! Follow PPI's LinkedIn page to make sure you don't miss the next one.

Watch the webinar on YouTube here

13.4 PPI Participation in the Second INCOSE Showcase Webinar

This summer INCOSE launched its new "Showcase Webinar" series of events. These webinars revisit the most popular topics from the past few years, and in addition to a live topic update presentation the series also includes a period of discussion on LinkedIn and a live closing session.

PPI is very pleased that INCOSE selected the topic of *PM-SE Integration* for the second of these new Showcase Webinar sessions. The ability to do great SE requires not only knowledge and training, but also "permission to succeed" in the form of appropriate time and resource allocations by PM.

During the June 15 session PPI Principal Consultant and course presenter Randall Iliff, along with colleagues Stephen Townsend from PMI and Eric Rebentisch from MIT, provided an update of the many actions that have taken place since the original webinar three years ago.

Stephen Townsend shared that the new PMI PMBOK structure was heavily influenced by system thinking and places greater responsibility on the PM to select methods based on need rather than offering a fixed model to apply. The INCOSE PM-SE Integration Working Group is reviewing the PMBOK draft and will provide comments on behalf of INCOSE.

Eric Rebentisch shared the increasing use of the book, "Integrating Program Management and Systems Engineering: Methods, Tools and Organizational Systems for Improving Performance" as a resource for SE training at the University level. Eric also shared the exciting news that, based on local interest and demand, the book is being translated for publication in Russia and China.

Within INCOSE the big change over the past three year period has been establishment of the official PM-SE Integration Working Group co-chaired by Tina Srivastava (tinaps@alum.mit.edu), Jean-Claude Roussel (jc.roussel6231@gmail.com) and John Lomax (john.lomax@airbus.com).

An archive copy of the Presentation is available at https://www.incose.org/about-incose/community/webinar-showcase

The overall event cycle concluded on June 29 with a live Zoom Q&A session. PPI would like to thank everyone who participated in this event, and we'd also like to extend an invitation to anyone interested in PM-SE integration to reach out to Randall Iliff with questions or comments!

14. PPI AND CTI EVENTS

For a full public PPI Live-Online™ training course schedule, please visit https://www.ppi-int.com/ppi-live-online/

For a full public PPI training course schedule, please visit https://www.ppi-int.com/course-schedule/

For a full public CTI Live-Online™ INCOSE SEP Exam Preparation course schedule, please visit https://certificationtraining-int.com/incose-sep-exam-prep-course/

To enquire about CTI Live-Online™ INCOSE SEP Exam Preparation Training for your organization, please visit https://certificationtraining-int.com/on-site-training/

15. UPCOMING PPI PARTICIPATION IN PROFESSIONAL CONFERENCES

PPI will be participating physically in the following upcoming events. We support the events that we are sponsoring, and look forward to meeting old friends and making new friends at the events at which we will be exhibiting.

The INCOSE Western States Regional Conference 2020

Date: 17 – 19 September, 2020

Location: Virtual

The INCOSE International Workshop 2021

Date: 29 – 31 January, 2021

Location: Seville, Spain

The INCOSE International Conference 2021

Date: 16 – 22 July, 2021

Location: Honolulu, USA

Kind regards from the PPI SyEN team:

Robert Halligan, Editor-in-Chief, email: rhalligan@ppi-int.com

Ralph Young, Editor, email: ryoung@ppi-int.com

René King, Managing Editor, email: rking@ppi-int.com

Project Performance International

2 Parkgate Drive, Ringwood, Vic 3134 Australia

Tel: +61 3 9876 7345

Fax: +61 3 9876 2664

Tel Brasil: +55 12 9 9780 3490

Tel UK: +44 20 3608 6754

Tel USA: +1 888 772 5174

Tel China: +86 188 5117 2867

Web: www.ppi-int.com

Email: contact@ppi-int.com

Tell us what you think of PPI SyEN. Email us at syen@ppi-int.info.