Emerging Research

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The Emerging Research topic under the SEBoK Emerging Knowledge is a place to showcase some of the systems engineering research published in the past 3-5 years.

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Contents

Doctoral Dissertations

Doctoral level systems engineering research has taken root over the last two decades. Additionally, many institutions have either an Industrial Engineering or Systems Engineering Master's program. This has enabled new and interesting research to be conducted. Here you will find bibliographic citations and summaries for recently defended research.

Towards Early Lifecycle Prediction of System Reliability

Salter, C. "Towards early lifecycle prediction of system reliability," Ph.D. dissertation University of South Alabama, Mobile, Alabama, July 2018. Available: ProQuest Store

Reliability is traditionally defined as "the probability that an item will perform a required function without failure under stated conditions for a stated period of time" (O'Connor, 2012). This definition is applicable to all levels of a system, from the smallest part to the system as a whole. Predicting reliability requires extensive knowledge of the system of interest, thus making prediction difficult and complex. This problem is further complicated by the desire to predict system reliability early in the acquisition lifecycle. This work set out to develop a model for the prediction of system reliability early in the system lifecycle. The model utilizes eight factors: number of system requirements, number of major interfaces, number of operational environments, requirements understanding, technology maturity, manufacturability, company experience, and performance convergence. These factors come together to form a model much like the software engineering and systems engineering models COCOMO and COSYSMO. This work provides the United States Department of Defense a capability that previously did not exist: the estimation of system reliability early in the system lifecycle. The research demonstrates that information available during early system development may be used to predict system reliability. Through testing, the author found that a model of this type could provide reliability predictions for military ground vehicles within 25% of their actual recorded reliability values.

Toward the Evolution of Information Digital Ecosystems

Lippert, K. "Toward the evolution of information digital ecosystems," Ph.D dissertation, University of South Alabama, Mobile, Alabama, May 2018. Available: ProQuest Store.

Digital ecosystems are the next generation of Internet and network applications, promising a whole new world of distributed and open systems that can interact, self-organize, evolve, and adapt. These ecosystems transcend traditional collaborative environments, such as client-

server, peer-to-peer, or hybrid models (e.g., web services) to become a self-organized, interactive environment. The complexity of these digital ecosystems will encourage evolution through adaptive processes and selective pressures of one member on another to satisfy interaction, adaptive organization, and, incidentally, human curiosity. This work addresses one of the essential parts of the digital ecosystem – the information architecture. The research, inspired by systems thinking influenced by both biological models and science fiction, applies the TRIZ method to the contradictions raised by evolving data. This inspired the application of patterns and metaphor as a means for coping with the evolution of the ecosystem. The metaphor is explored as a model of representation of rapidly changing information through a demonstration of an adaptive digital ecosystem. The combination of this type of data representation with dynamic programming and adaptive interfaces will enable the development of the various components required by a true digital ecosystem.

Cybersecurity Decision Patterns as Adaptive Knowledge Encoding in Cybersecurity Operations

Willett, K. "Cybersecurity decision patterns as adaptive knowledge encoding in cybersecurity operations", Ph.D. dissertation, Stevens Institute of Technology, Hoboken, NJ, July 2016. Available: https://pqdtopen.proquest.com/doc/1875237837.html?FMT=ABS.

Cyberspace adversaries perform successful exploits using automated adaptable tools. Cyberspace defense is too slow because existing response solutions require humans in-the-loop across sensing, sense-making, decision-making, acting, command, and control of security operations (Dōne et al. 2016). Security automation is necessary to provide for cyber defense dynamic adaptability in response to an agile adversary with intelligence and intent who adapts quickly to exploit new vulnerabilities and new safeguards. The rules for machine-encoding security automation must come from people; from their knowledge validated through their real-world experience. Cybersecurity Decision Patterns as Adaptive Knowledge Encoding in Cybersecurity Operations introduces cybersecurity decision patterns (CDPs) as formal knowledge representation to capture, codify, and share knowledge to introduce and enhance security automation with the intent to improve

cybersecurity operations efficiency for processing anomalies.

INCOSE & IEEE Periodicals and Events

Every year, the International Council on Systems Engineering (INCOSE) holds one International Workshop and one International Symposium, as well as regular meetings of various working groups, to encourage discussions of emerging needs and sharing of experience within Systems Engineering community. All papers and presentations from these events are available for free for INCOSE members, or with a fee for non-members via Wiley. The library can be access here: https://www.incose.org/products-and-publications/papers -presentations-library#

Additionally, INCOSE also publish periodicals, which include: Systems Engineering (SE Journal), INSIGHT (magazine), and INCOSE Members Newsletter. These periodicals are available as PDF, free for INCOSE members and with a fee for non-members, or as hard copies. More information can be found here: https://www.incose.org/products-and-publications/period icals

The Institute of Electrical and Electronics Engineers (IEEE) Systems Council also holds multiple annual conferences, such as the International Systems Conference (SysCon), on systems engineering, resulting in a large pool of publications. These publications can be found via: https://ieeesystemscouncil.org/publications

NSF- and SERC-funded Research

The National Science Foundation (NSF), Division of Civil, Mechanical, and Manufacturing Innovation (CMMI) has been funding research in academia on systems engineering under Engineering Design and Systems Engineering (EDSE) program. According to NSF-EDSE website, the program "seeks proposals leading to improved understanding about how processes, organizational structure, social interactions, strategic decision making, and other factors impact success in the planning and execution of engineering design and systems engineering projects". Research under this program can be found via Award Search feature on NSF website: https://www.nsf.gov/awardsearch/advancedSearch.jsp

(Enter "CMMI" for NSF Organization and "EDSE" for Program).

The Systems Engineering Research Center (SERC) is a University-Affiliated Research Center of the US Department of Defense, consisting of 22 collaborator universities in the US and funding research on different aspects of Systems Engineering, including Enterprises and System of Systems, Trusted Systems, Systems Engineering and Systems Management Transformation. More information can be found here: https://sercuarc.org/serc-programs-projects/esos/

References

None.

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