

SSE RESEARCH DAY
Presentation Abstracts
May 5-6, 2008

Using Process Simulation to Manage New Product Development Pipeline Throughput

Meg Smith

Advisor: Dr. John Farr

Historically, modeling and simulation has been utilized to optimize manufacturing processes. There are numerous examples in the literature, however, of process modeling for the improvement of single new product development projects. Each of these examples takes a different approach to moderately different goals, under the common umbrella of improving the new product development process. What is common among all of the single project simulation efforts is process adherence, which rarely occurs. Modeling how the process is actually utilized under organizational pressures, is equally important. The research proposed is to incorporate some common organizational pathologies and characteristics, consistent with the literature and the researcher's experience, to show how business decisions are often detrimental to pipeline throughput. The literature is very consistent about the benefits of cross functional integration and the challenge of resource overload, prevalent in many organizations. Modeling to demonstrate this challenge is scarce. This project will consider the fact that queues may not really occur in new product development, so using queue theory is not always an accurate method for portraying capacity constraints. In addition, the data of decreased efficiencies when capacity of any discipline exceeds 70% will also be incorporated to show how the pipeline slows down when these inefficiencies arise.

Identification and Analysis of Key Risk Factors Associated with Outsourcing Complex Systems

Jimmy Gandhi

Advisor: Dr. Brian Sauser

Evolution of the global economy has brought forth reduced labor costs and operating expenditures yielding a competitive world-wide market that will continue to place more emphasis on outsourcing. This is largely due to the proliferation of technology that has brought global competitive forces into the virtual backyard of U.S manufacturing firms and businesses. As this trend continues to evolve, the outsourcing of complex systems has become a phenomenon; with this comes various risks associated with outsourcing. This research presentation will identify and analyze key risk factors associated with outsourcing complex systems. Risk factors discussed in this presentation include schedule, cost, technology transfer, requirements management, interoperability and supportability. Based on the literature review an outsourcing risk assessment chart is provided. The intent of this chart is to provide a guideline for project engineers and risk managers to consider when evaluating risk factors associated with outsourcing complex systems.

Ranking of outsourcing risks can be looked at from two perspectives – The perspective of the company that is outsourcing as well as the perspective of the company receiving the outsourcing contract. The ranking / clustering of the outsourcing risks are likely to vary based on the perspective taken into consideration as well as on the type of product, location of the vendor, size of the project, its duration and its complexity. Lastly, this presentation will discuss methodologies through which the risks identified can be ranked / clustered so that organizations involved in the outsourcing of complex systems know how to allocate their risk mitigation resources.

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Developing an Effective System of Systems Engineering (SoSE) Management Framework

Alex Gorod

Advisor: Dr. Brian Sauser

As the world experienced major structural and operational changes in production and manufacturing around World War II, there was a significant evolutionary paradigm shift in dealing with new complexities by introducing new engineering techniques that focused on a single complex system rather than separate individual components. It became known as the discipline of Systems Engineering (SE). Still, a process of rapid global acceleration, especially in the military sector continued and called for the next level of development in engineering. The objective was to address "...shortcomings in the ability to deal with difficulties generated by increasingly complex and interrelated system of systems" (Keating et al, 2005). There was a need for a discipline that focuses on engineering of multiple integrated complex systems. Today this discipline is known as System of System Engineering (SoSE).

There have been numerous attempts to define what SoS are and how we may engineer them; however, a universally accepted definition still does not exist. Alternatively, some researchers and practitioners have taken a different approach by focusing on distinguishing characteristics rather than providing an abstract definition of the SoS.

The alternative approach provides a more comprehensive and precise taxonomy due to the fact that the definitional approach is limited to industry specific context and lacks general flexibility necessary in successful dynamic trans-disciplinary engineering process. The review of modern literature indicates that the use of characteristics enables us to better identify dynamic nature of various forces within SoS. In my research, I will utilize the distinguishing characteristics of SoS as "building blocks" to create an effective SoSE management framework.

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System of Systems – A System of Meaning

Michael DiMario

Advisor: Dr. John Boardman

A System of Systems is not an aggregate of the individual constituent systems and their characteristics, but a structure of “interpersonal” ties that manifests itself as another system. It is a relationship mapped among a set of objects or actors. The affiliation of these systems is structural and produced by a circumstance, as are affiliations of members of a group in human society. The environment circumstance provides a reason for autonomous systems to interoperate according to their own perspectives and through the resultant affiliations spawns a new culture of systems or system that is not found within the constituent systems operating in the same environment. The quality of interactions or interoperation of systems is based on a degree of coordination, cooperation, and collaboration leading to a coalition or consensus.

For autonomous systems to cooperate with one another there is a sharing of resources to achieve a greater purpose. A thesis of developing a methodology to construct such systems is reviewed. Methodology encompasses the use of network analysis and UML or agent based modeling.

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A Generic Method for Estimating Complex System Reliability Using Bayesian Networks

Ozge Doguc

Advisor: Dr. Jose Emmanuel Ramirez-Marquez

This study presents a holistic method for estimating complex system reliability via Bayesian networks (BN). Although recent studies on using BN for system reliability estimation have been proposed, they are based on the assumption that pre-built BN have been designed to represent the systems. In these studies, the task of building the BN is typically left to a group of specialists who are BN and domain experts. Based on the extensive literature review, this is the first study that incorporates various methods for estimating system reliability and eliminating the need for human intervention. For this purpose the *K2*, an unsupervised data mining algorithm, is used for discovering the associations between the system components and thus, building the BN model. Also experimental results are presented to demonstrate efficiency and accuracy of the proposed methodology for estimating complex system reliability.

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Exploring Systems Engineering Attributes

George Elias

Advisor: Dr. Rashmi Jain

Methods to insure that a system meets its intended requirements are important especially when performing architectures analysis, requirement generation, trade-offs, reviews and verifications of designs. One approach is to use methods that focus on system attributes. The key to success in this approach is to understand which attributes should be addressed and how they relate to the system. There exists little research in the systems engineering community on the role of system attributes and how they apply to systems architecture. This presentation focuses on my current research related to system attributes.

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*The Modeling of Conceptual Spaces and the Choquet Integral for the Establishment of
Knowledge in Distributed Tactical Systems for Combat Identification*

Tod Schuck

Advisor: Dr. Wei Jiang

For the representation of knowledge in systems, the question becomes one of how to identify the essential components of knowledge that can be established. This research application objective is to achieve a robust Combat ID a distributed tactical military system. For this Stevens Research Day presentation, the intent is to demonstrate progress in mapping the Combat Identification domain to Gärdenfors' Conceptual Spaces constructs. Also, multiple runs of simulated sensor information to instantiate knowledge using the Choquet Integral function will be reviewed. Both of these concepts will be linked in the presentation. Additionally, the results of a user survey to suggest effective knowledge representation methods for tactical system operators may also be presented.

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Architectural Vulnerability in Self Organizing Systems: Designing for Targeted Attacks

John Wirsbinski

Advisor: Dr. John Boardman

This presentation outlines the proposed direction for my research: to discover architectural heuristics to characterize the vulnerability of self organizing systems to targeted attacks. As interest grows in engineering and deploying these systems, methodologies for assuring their security must be developed. Most research to date has focused on the engineering tasks associated with the operational predictability of these systems. This research proposes to extend previous work in the fields of robotics, machine intelligence, networks, intelligent control, system of systems engineering, and security to understand the patterns of vulnerability intrinsic to different self organizing architectures. If successful, this research lays the groundwork for additional research into security heuristics for system architecture, security as a measure of system readiness, and methods for securing self organizing systems.

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Exploring Relationships between Systems Thinking and K-12 Education

Alice Squires

Advisor: Dr. Michael Pennotti

Due to the extraordinary levels of integration possible with developing technologies, the complexity of human engineered systems is increasing at unprecedented rates. This trend is occurring across a broad set of industries from health care to mobile communications to homeland defense; and at all levels of design from the “System on a Chip” that fits in the palm of the hand to the “Systems of Systems” that pervade military networks. As the complexity of systems increases, so too does the requirement for systems thinking. And systems thinking is no longer reserved for experienced system architects and engineers –members of the general public have to make informed choices about very complex, highly interrelated systems. Yet the role of education in developing or inhibiting systems thinking is not well defined. Some believe systems thinking requires aptitude at birth. Others contend that systems thinking is the purview of those with over half a dozen decades of experience. As an introduction into the topic, this paper focuses specifically on identifying existing relationships between systems thinking and Kindergarten through the twelfth grade (K-12) education.

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Requirements Dependencies: Do they actually exist?

Vishwajeet Kulshreshtha

Advisor: Dr. John Boardman

Do system requirements themselves form a system, an object that satisfies systemic criteria? If the answer is affirmative, then we assert that relationships between requirements (parts in the requirements system) must exist, so that the 'whole' that emerges, can be considered as a system. While a singular requirement conveys partial information about a system, a requirements system might convey insights that predicate such a holistic perspective.

My research interest lies in potentially leveraging the requirements system to concentrate on the vital few requirements (as opposed to the trivial many). If these vital few requirements, together with their rationale, exist, then we believe they can be leveraged to expedite the requirements engineering process, facilitate the inevitable trade studies, and thereby make system development more effective. Accordingly, an emphasis in this paper is on understanding the nature and types of requirements relationships that might exist. An extensive literature search and a consolidation of findings are presented herein. The conclusions are presented in the form of a proposed research agenda.
