Honourcode, Inc.
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Systems of Systems Engineering

Technical Leadership in a Networked World

A 2-Day Course

Presenting Sound Solutions for Complexity in the areas of Architecting, Integration, Collaboration, and Test

Today's environments are dominated by complex systems of systems (SoS), created by the networking of many systems to create larger emergent capabilities. As a result, systems engineers now often have the difficult responsibility to develop and manage systems within the overriding context of an SoS.

The development environment for a system of systems is typically characterized by its own unique challenges, such as a decades-long life cycle and ongoing re-architecting throughout that lifecycle. System success under these conditions requires developing an adaptable design in a dynamic process to manage complexity, while supporting shifting operational priorities over significant time spans and avoiding the lurking potential of chaotic conditions.

To meet these challenges, this course presents detailed, useful techniques to work effectively within the context of systems of systems and to manage the engineering activities associated with them. The course builds on the most recent SoS research and experience from INCOSE, NDIA, SERC, and several EU projects.

***You should attend this course if you are*:**

- A leader or a key team member of a system operating within an SoS.
- Connecting your existing systems with other systems
- Struggling with complexity and chaos issues that arise from your system environment.
- Looking for practical methods to use today

The course is aimed at

- Program managers,
- Project managers,
- Systems engineers,
- Technical team leaders,
- Logistic support leaders, and
- Others who participate in defining and developing complex systems.

Practice the skills on a realistic case study in system development within an SoS. Student groups work to define the SoS so that their individual systems can both collaborate and compete effectively

The ***Smart Highway Exercise*** gives students the opportunity to practice the skills taught in the course while exploring the future of automated highways.

Topics Covered in the Course

Introduction – Systems of Systems concepts. Expectations for what an SoS can achieve. Terms and definitions.

- What is a system of systems?
- Operational environment: geographic distribution, concurrent operations
- Recent research areas and successes
- Development issues: evolutionary, large scale, distributed
- Issues for the constituent system that must fit into an SoS

Systems of Systems Challenges – Complexity issues versus traditional systems engineering. Systems engineering in transition. Paradigm shifts. Framework for working with systems of systems

- SoS Pain Points gathered by INCOSE SoS working group.
- Complexity and chaos as an underlying principle
- Issues in complex adaptive systems: attractors, adaptation, autocatalysis, nonlinear dynamics
- Emergent behavior and the use of patterns
- Self-organization in SoS
- Problems with traditional systems engineering in relation to SoS.
- New paradigms for engineering complex systems
- The DoD Wave model for iterative development of an SoS
- EU research projects and what they have created for SoS engineering: DANSE, COMPASS
- DoD research in SoS under the Systems Engineering Research Center (SERC)

Architecture Solutions – Design strategies for SoS reflect the independent origin of the included systems, greater scale and complexity of the SoS environment, and the distinct lifecycle of the SoS.

- Strategies for the constituent system SE
- Large scale architectures
- Architectural Frameworks: UPDM (DoDAF/ MoDAF/NAF), TOGAF, Zachman, FEAF
- UPDM views and how they work
- The DANSE and COMPASS approaches to SoS modeling
- Dynamic optimization, the bottom-up approach that happens by itself
- Patterns in architecting and how to use them

Integration Solutions – Integration strategies for SoS cope with the dynamic character of the SoS environment, the presence of systems that originated outside the immediate control of the project staff, and the difficulty of anticipating shifting SoS priorities over the operating life of the systems.

- Interface definition and control as a way to control the complexity
- Examples/lessons from world-class TCP/IP
- Coupling and interoperability, how to control the interactions among systems and humans
- Legacy Systems as used in an SoS

Collaboration Solutions – The SoS environment puts special demands on the systems engineering processes. Collaborative efforts often extend over long periods of time and can require effort across organizational contexts. SoS often have many systems engineers collaborating explicitly or implicitly, at the same time (concurrently) or at disjoint times. Collaboration may occur over decades.

- Working with multiple, cross-connected teams
- Roles of project leaders in SoS development, both SoS and constituent system leaders
- Strategies for managing collaboration
- Politics as a systems engineering tool
- Managing program interfaces using control versus influence
- Strategies for maintaining integrity of systems engineering efforts over long periods of time when working in independent organizations.

Testing and Evaluation Solutions – Testing and evaluation in the SoS environment present unique challenges due to the evolutionary nature of development. Multiple levels of T&E are necessary, and the usual success criteria no longer suffice.

- Multiple levels of T&E
- Evaluating SoS interfaces - why interface testing is necessary but isn't enough
- Validating the functional footprint of the SoS
- Evaluating SoS dynamics
- Finding and evaluating emergent behavior, both favorable and detrimental

The Presenters:

Dr. Eric Honour, CSEP, INCOSE Fellow, and former INCOSE President, has been in international leadership of the engineering of systems for 20 years, part of a 45+ year career of complex systems development and operation. His energetic and informative presentation style actively involves class participants. He was the founding Chair of the INCOSE Technical Board in 1994, and served as Director of the Systems Engineering Center of Excellence (SECOE). He was selected in 2000 for Who's Who in Science and Technology and in 2004 as an INCOSE Founder. He is on the editorial board for *Systems Engineering*. He has been a successful entrepreneur, systems engineer, engineering manager, and program manager at Harris Information Systems, E-Systems Melpar, and Singer Link, preceded by nine years as a US Naval Officer flying P-3 aircraft. He has led or contributed to the development of 17 major systems, including the Air Combat Maneuvering Instrumentation systems, the Battle Group Passive Horizon Extension System, the National Crime Information Center, and the DDC1200 Digital Zone Control system for heating and air conditioning. Dr. Honour now heads Honourcode, Inc., a training and consulting firm offering effective methods in the development of system products. Dr. Honour has a BSSE (Systems Engineering) from the US Naval Academy, MSEE from the Naval Postgraduate School, and PhD from the University of South Australia based on his ground-breaking work to quantify the value of systems engineering.

Dr. Scott Workinger has led innovative technology development efforts in complex, risk-laden environments for 30 years in the fields of manufacturing (automotive, glass, optical fiber), engineering and construction (nuclear, pulp & paper), and information technology (expert systems, operations analysis, CAD, collaboration technology). His experience includes the human factors of complex modeling environments, including development of a commercial modeling tool. He currently teaches courses on program management and engineering and consults on strategic management and technology issues. Scott has a B.S in Engineering Physics from Lehigh University, an M.S. in Systems Engineering from the University of Arizona, and a Ph.D. in Civil and Environment Engineering from Stanford University.