



Complex Systems

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Charter Summary



WG PURPOSE/MISSION

The purpose of the Complex Systems Working Group is to enhance the ability of the systems engineering community to deal with phenomenology associated with complex and complex adaptive systems. The Complex Systems Working Group works at the intersection of complex systems sciences and systems engineering, focusing on systems beyond those for which traditional systems engineering approaches and methods were developed.

WG GOAL(S)

- Communicate complexity characteristics to systems engineering practitioners
- Provide knowledge and expertise on complex systems in support of other INCOSE working groups working in their systems engineering areas
- Facilitate the identification of tools and techniques to apply in the engineering of complex systems
- Provide a map of the current, diverse literature on complex systems to those interested in gaining an understanding of complexity.

WG SCOPE

The Complex Systems Working Group focuses on the challenges and opportunities presented by systems with rich interdependence among diverse components, non-linearity, open systems boundaries, networks of causality and influence (vice linear causal chains), emergence, varied and changing system goals, self-organization, and multi-level adaptation. These traits limit the utility of traditional systems engineering paradigms, which are generally centralized, goal oriented, requirements driven, and reductionist in approach. These traits, however, are increasingly the norm and not the exception. The Complex Systems Working Group collaborates with the Systems Sciences Working Group to define the scientific basis of these characteristics.

Further, complexity is a characteristic of more than just a technical system being developed. The socio-technical ecosystem in which a system under development will be employed exhibits these attributes, as does the environment that gave rise to the challenge or opportunity to which the system was developed in response. Further, the design and development of technical systems is a complex endeavor itself. It is critical for systems engineers to understand the nature of the systems with which they are working, and of which they are a part, to be effective.

IW Outcomes



IW Outcomes

- Provided WG information and context for new participants
- Briefed WG on complex systems contents from the *Complexity Primer for Systems Engineers* as an overview to key ideas relevant for the WG
- Received presentation from Mat French (Rolls Royce) on Porous System Boundaries
- Received presentation from Jim Moore (JM Technologies) on *The Computable Universe: A Case Study of the Model Based Approach*
- Met with Natural Systems WG to present and discuss collaborative project on *Complex Systems Exemplars*
- Met with Critical Infrastructure and Protection WG to discuss complexity considerations for CIPR
- Met with Systems Science WG for discussions of patterns, category theory, and system pathologies
- Developed candidate projects for work in 2019



Planned Work past IW



PLANNED ACTIVITIES

- Leverage insights from Complex Systems Exemplars project to inform revision to Complexity Primer
- Develop core INCOSE material for Managing Complexity in Systems Engineering (papers, prototypes/pilots, case studies, SEBoK contributions, SE Handbook contributions
- Develop guiding principles for modeling complexity what do you have to do differently?
- Explore applicability of Cynefin framework in SE contexts
- Engage with Competency WG to develop needed competencies when working in contexts of complexity
- Complexity considerations for AI engineering and operation
- Complexity considerations for Enterprise Systems (with ESWG)
- Complexity considerations for Critical Infrastructure Protection and Recovery (with CIPR WG)
- Building simulations to illustrate and explore key complex systems concepts
- Webinars on complex systems topics for INCOSE members

PLANNED WORK PRODUCTS

• Complexity Primer for Systems Engineers, Version 2

