

# Enabling Transdisciplinary Potential in Complex Adaptive Systems (CAS):

*Would a More Holistic Modeling Approach and Blending of Practices Across the Natural Systems (NS), Systems Engineering (SE), Program Management (PM), and cNES\* (Coupled Natural and Engineered Systems) Communities Be Helpful?*

**Overview:** It is generally accepted in systems communities that transdisciplinary approaches are more effective, if not necessary, in situations of high complexity. Positive results in education, research, engineering, management and other areas have been produced. The International Council On Systems Engineering (INCOSE) states that .... “Systems Engineering is a **transdisciplinary** and integrative approach to enable the successful realization, use, and retirement of engineered systems, using systems principles and concepts, and scientific, technological, and management methods.” All Engineered Systems exist and operate within Natural Systems, and Natural Systems are increasingly impacted by Engineered Systems and what they produce, whether intended or unintended. The number of Natural Systems requiring protection and management is on the rise, and the benefits of holistic perspectives, e.g., cNES\* (Coupled Natural and Engineered Systems) are becoming more evident. A premise of this workshop is that transdisciplinary interaction and more holistic system-of-systems (SoS) level views could be beneficial. Participation and active engagement from members of academia, industry, government, and professional associations involved with the study, engineering, operation, management, and effects of complex systems are welcome.

### Proposed Discussion Areas:

**1. Types of Systems, Associated Disciplines, and Key Areas for Transdisciplinary Collaboration:** In this topic area a “high level” holistic view of types of systems, their respective life cycles, and the scope and breadth of disciplines involved over the system life cycles is developed. *What are the challenges and opportunities?*

- Natural Systems (NS), Engineered Systems (ES), and cNES\* (Coupled Natural and Engineered Systems)
- System Life Cycles, Disciplines, Taxonomies, Ontologies, Development & Management Systems

**2. Status, Examples and Practices for Implementing Transdisciplinary Collaboration:** Transformative collaborative efforts are underway in the Systems Engineering (SE) and Program Management (PM) communities. *What is working, what is not? Can the PM-SE integration concepts be extended to the NS and cNES communities?*

- INCOSE PM-SE Integration WG and related PMI-INCOSE-MIT (Wiley) Book. Integrated Risk Mgmt for SE.
- The WFEO-INCOSE WG: Transdisciplinarity over the increasing number & variety of engineering disciplines.
- Overview, status, and examples from the NS and cNES\* communities, and in academia, professional associations, government, industry, and any areas of related study and research

**3. Processes, Methods and Tools for Transdisciplinary Communication and Collaboration:** The environments in which complex Natural, Engineered and cNES\* (Coupled Natural and Engineered Systems) are analyzed, developed, and managed can be viewed as Complex Adaptive Transdisciplinary Systems (CATS). New technologies and tools can enable, facilitate and even accelerate the implementation and utilization of transdisciplinary related activities and processes, but if care is not taken, there can be unintended negative effects. *Are there any areas of concern currently emerging? What are the challenges and opportunities?*

- Digitization – Digital Engineering/Twins, MBSE, Modeling & Simulation tool Interoperability, Industry 5.0.
- Potential Enablers – Transdisciplinary Frameworks & Processes, Systems Dynamics, Artificial Intelligence, Human Systems Integration, Focus on Human-Consumable Outputs, Virtual Reality.

\* NOTE: The term/acronym “cNES” has been chosen to represent all terms/acronyms for the same/similar concept, including but not limited to “Coupled Human-Engineered and Natural Systems” (Purdue); Los Alamos Lab’s cNES; “Coupled Human And Natural Systems” or CHANS; the U.S. NSF’s “Dynamics of Coupled Natural and Human Systems” DISES, and so on.