

Overview of Research Task

This research task addresses the research needs defined by the United States (US) Army RDECOM-ARDEC in Picatinny, NJ. These needs are characterized as overarching objectives and goals to **elicit requirements for the Armament Virtual Collaboratory Environment (AVCE)** for the first phase of this effort. The AVCE is ARDEC's envisioned concept of an integrated modeling environment - **"the system for designing future ARDEC systems or systems-of-systems."** With an intent to understand the relationships between Systems Engineering (SE) activities in the context of a Digital Thread concept developed by ARDEC, this research task is investigating a transformation for systems engineering enabled by **model-centric engineering (MCE)**.

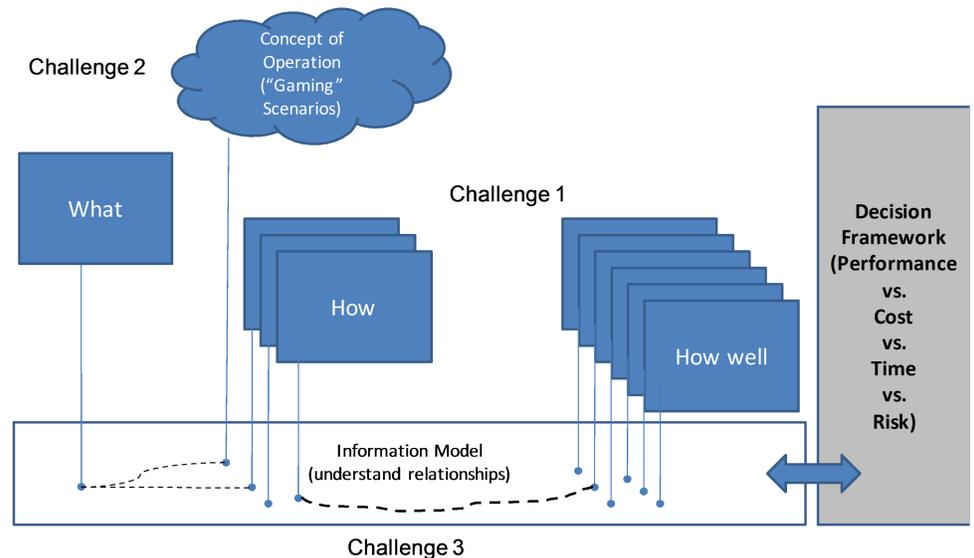
Research Challenge Areas

To better understand the requirements for the AVCE, ARDEC has identified **three challenge areas** to investigate the research tasks:

#1: Taking existing ARDEC models and combining them to form dynamic models at the system level, and to explore Multidisciplinary Design, Analysis and Optimization (MDAO).

#2: Understanding the whole process of solving a problem, including the people who are involved, from a CONOPS enabled by gaming technologies, and mission-level modeling and simulation that can ultimately feed information to a framework refined by Challenge #1.

#3: The focus here is on the data, and how it propagates throughout the lifecycle, and be able to use a standards-based tool-neutral approach to "integrate" modeling and analysis that are often heterogeneous and disparate.



The concept for these three challenges is shown in the Figure. We notionally define:

Concept of Operations (CONOPS) derived from simulation and gaming technologies;

"What" we want – requirements and constraints; **"How"** (1 or more) – designs to achieve the "What"; **"How well"** (usually many) to assess the "How" using analysis, testing, reviews and assessing how the design satisfies the requirements, given the constraints to achieve the mission concept;

The underlying **Information Model** links the data or metadata from many different domains; The **Decision Framework** can demonstrate how data from the information model can be used to populate the Decision Framework,

Evolving Research Approach

Using a Model Based System Engineering (MBSE) approach to model our project, we have elaborated the research tasks using high-level use cases, and associating them with researchers.

❖ **UC00** Develop Information Model that characterizes the underlying information and relationships to "everything" that might need to be produced by the tools of AVCE.

❖ **UC01** Investigate the use of Graphical CONOPS technologies such as gaming environments. This information would be mapped to UC00 and be provided as input to UC02.

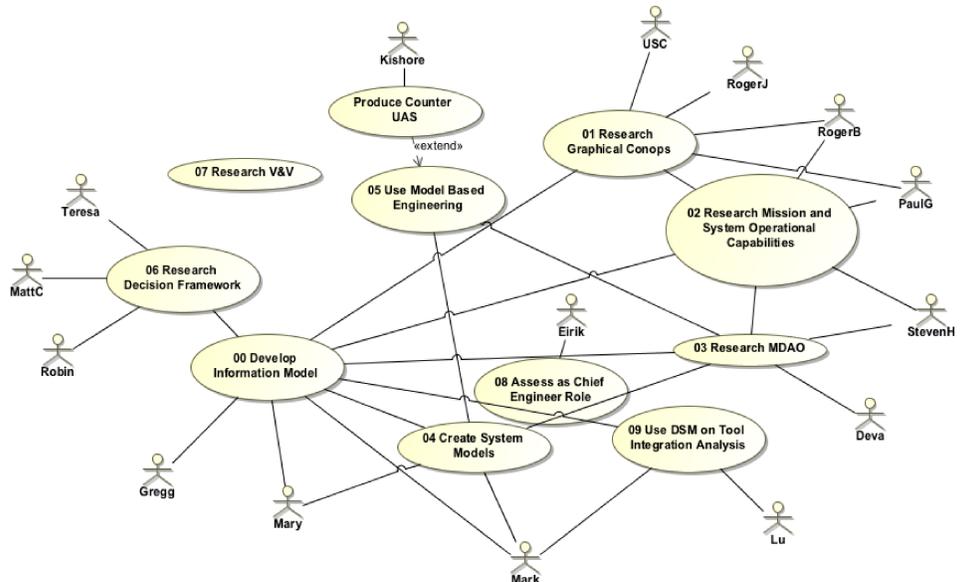
❖ **UC02** Investigate the methodological and relevant technologies for mapping the Graphical CONOPS into Mission and System modeling and simulation capabilities.

❖ **UC03** Investigate the method to trace capabilities to the relevant design disciplines and perform cross-domain analyses through MDAO for problem and design tradespace analyses.

❖ **UC04** Create System Models, applying MBSE to the case study examples and looking at how metamodels or metadata is represented in the Information Model to provide traceability through the other forms of modeling for UC01, UC02, UC03 and UC05.

❖ **UC05** Apply Model-Based Engineering (MBE) typically associated with the different design disciplines (e.g., electrical, mechanical, controls). We are interested in how metamodels from these various domain or metadata are represented in the Information Model to provide cross-domain traceability.

❖ **UC06** Research Decision Framework, to capture information that can be used to provide input to the Decision Framework. This would provide the type of information needed to consider technology capability tradeoff using Performance, Cost, Time and Risk. If a particular answer is unacceptable, we could trace linkages through the Information model back to all other related perspectives on the system (UC01, UC02, UC03, UC04, UC05).



❖ **UC07** Research Verification and Validation (V&V). Rigorously defined models can directly support V&V, and this could both subsume cost and risks.

❖ **UC08** Assess as Chief Engineering Role, to provide some level of assessment of our overarching approach and contribute to the requirements for AVCE.

❖ **UC09** Use Design Structure Matrix on Tool Integration Analysis, seeking to support the requirements analysis using a technology and method associated with architecture assessment.

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