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Interactive Model-Centric Systems Engineering
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SYSTEMS ENGINEERING RESEARCH CENTER

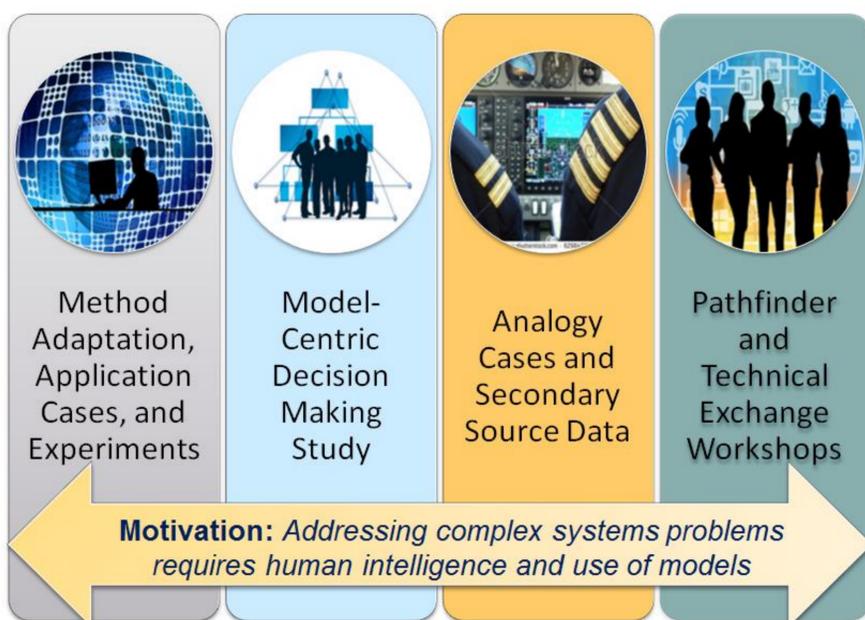SEA RI — MIT Systems Engineering Advancement Research Initiative

Research Task / Overview

Over the past four years, the research program has investigated various aspects of humans interacting with models and model-generated data, in the context of systems engineering practice. Key questions include:

o *How do humans interact with models and model-generated information, and with each other through models?*

o *What guiding principles can be used to inform effective digital engineering practice, from the human-model perspective?*

o *What are essential human roles and responsibilities in model-centric environments?*

o *What new roles are needed in the future digital engineering enterprise?*

Research Approach

The research approach involves using many different research methods and engages with the research stakeholder community through multiple means.

Method Adaptation, Application Cases, and Experiments

Model-Centric Decision Making Study

Analogy Cases and Secondary Source Data

Pathfinder and Technical Exchange Workshops

Motivation: *Addressing complex systems problems requires human intelligence and use of models*

Research Activities

The present phase of the research is investigating two topic areas through the activities described below:

Human-Model Interaction Principles & Patterns

o Investigate research studies/lessons from relevant cases

o Conduct experiments and pilot studies with HMI heuristics

o Formulate HMI guiding principles for multiple purposes (education, project launch, model design, etc.)

o Investigate pattern approach to describe interactions

Model Curation/Model Curator Role

o Investigate curation role as means to address challenges and needs in model-centric enterprises

o Research roles and responsibilities, and alternative organizational forms for model curation leadership

o Engage research stakeholders in capturing a standard for "model pedigree"

o Investigate competencies and capabilities for model curation

Goals & Objectives

IMCSE research program seeks to inform and contribute new knowledge and MPTs to improve interactivity of humans and models in support of digital engineering.

Objectives of this phase are:

• **Guiding Principles and Patterns for Human-Model Interaction:** Mature human-model interaction heuristics to guiding principle and test application of principles in practice

• **Framework for Assessing Model-Centric Enterprise Capabilities:** Continue investigation of model curation and the requisite enterprise capabilities, with approach for assessment

Glimpses of Ongoing Work

Factors related to Model Trust and Integrity
Various factors have been identified through a decision-maker study, secondary source data, literature, and experiments.

TECHNICAL FACTORS	SOCIAL FACTORS	COGNITIVE/PERCEPTUAL
Model Complexity	Talent/Skills of People	Automation Bias
Data Availability	Inertia/Resistance to Change	Complacency
Data Quality	Changing Preferences	Mode Errors
Fidelity and Uncertainty	Lack of Trust	Anchoring Bias
Inadequate Methods	Generational Differences	Information Overload
Lack of Transparency	Willingness to Share Models	Preference-Performance Dissociation
Verified Algorithms	Ability to Socialize Models	

Model Curator
Research has led to formulation of a model curator role, defined as *a designated professional role entrusted with the ownership, tracking and use of model collection objects, and possessing designated authorities for managing and controlling models.*

Model Curation Lexicon under development

Model Collection	The collection of model-based assets that is possessed by an enterprise, including those developed by the enterprise, acquired by the enterprise, and temporarily resident in the collection (e.g., leased, on loan).
Model Collection Object	A model or model-related object that is a unique asset in the enterprise's collection. An object is assigned a unique identifier.
Model Composition	The process of composing models and model-related information that provides collective value beyond the individual models.
Model Composability	The characteristic of an interrelated set of models that enables them to be combined in accordance with given modeling formalisms.

Future Research

o Continue empirical investigation of model-centric decision making and patterns of interaction

o Investigate self-assessment approaches for assessment of model-centric environments, as relevant to curation

o Form partnerships to transition HMI principles and model curation research outcomes into broader community initiative

o Investigate and further develop MPTs in support of IMCSE

o Publish research findings on HMI and model curation/curator leadership role

Contacts/References

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Research reports available on SERC website
Recent papers and prototypes available at seari.mit.edu