RT-162
Interactive Model-Centric Systems Engineering

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SYSTEMS ENGINEERING RESEARCH CENTER

SEA RI
MIT Systems Engineering Advancement Research Initiative

Research Task / Overview

Models have significantly changed systems engineering practice over the past decade and continue to do so…

Significant progress on theory/practice of model-based systems engineering, insufficient focus on human-model interaction

IMCSE research program seeks to inform and contribute methods, processes and tools to improve interactivity of humans and models in support of decision-making
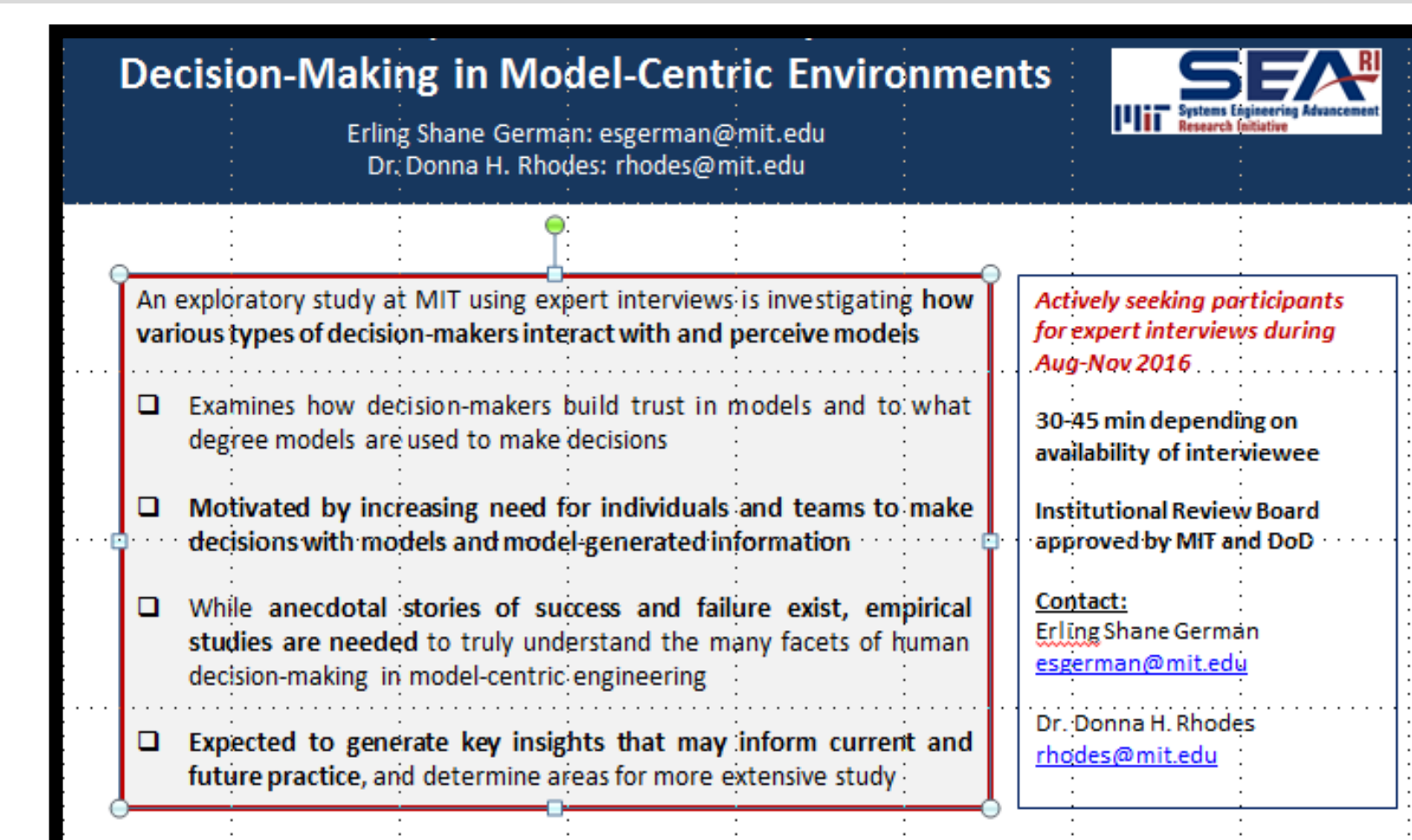
Interact with models individually and in teams

Goals & Objectives

Develop transformative results through enabling **intense human-model interaction**, to rapidly conceive of systems and interact with models in order to make rapid trades to decide on what is most effective given present knowledge and future uncertainties, as well as what is practical given resources and constraints

…ultimate goal is achieving effective "human-model teaming"

Research Activities

Recent and ongoing research seeks to address fundamental questions through empirical studies, experiments, prototypes, and case studies….

o *How do humans interact with models and model-generated information?*

o *How do humans interact with each other through using models?*

o *How can decisions be improved through model interaction?*

o *What cognitive challenges exist for model-informed decision-making?*

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

Models are "abstractions of reality" … gap between model and system is narrowing

Higher probability errors and omissions in a model lead to system failures

Humans need to be endogenous to interactive model-centric environments

Interactive Epoch-Era Analysis
o Mature framework with associated supporting tools to a case analysis including various types of uncertainties
o Case application to elicit feedback on relevance, ease of use, feasibility, tractability of data scaling and visualization techniques
o Develop interactive visualization demonstration prototypes

Human-Model Interaction
o Investigate key considerations through relevant literature, studies, and lessons from relevant past cases
o Conduct empirical study of model-centric decision making
o Gather and derive preliminary heuristics/design principles, adapted for human-model applicability
o Synthesize knowledge as guidance for model developers, model users, decision makers

Curation of Model-Centric Environments
o Investigate need for curation function given model challenges and emerging model-centric environments
o Gather and derive model curation roles and responsibilities
o Capture elements of "model pedigree"

Glimpses of Ongoing Work

Research Questions: What is the current state of the practice of decision-making using models and model generated information?

Ongoing interview-based investigation explores use of models in decisions, and issues of trust and perception of models

Decision-Making in Model-Centric Environments
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Dr. Donna H. Rhodes: rhodes@mit.edu

An exploratory study at MIT using expert interviews is investigating how various types of decision-makers interact with and perceive models

☐ Examines how decision-makers build trust in models and to what degree models are used to make decisions

☐ Motivated by increasing need for individuals and teams to make decisions with models and model-generated information

☐ While anecdotal stories of success and failure exist, empirical studies are needed to truly understand the many facets of human decision-making in model-centric engineering

☐ Expected to generate key insights that may inform current and future practice, and determine areas for more extensive study

Actively seeking participants for expert interviews during Aug-Nov 2016

30-45 min depending on availability of interviewee

Institutional Review Board approved by MIT and DoD

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Research Question: Would a model curation role address key challenges and needs? What competencies are needed?

• Legacy models not widely used beyond their original purpose
• Modeling efforts duplicated, re-use suffers from a lack of access, trust and legitimacy
• Modeling competency distributed across individuals/ organizations, not leveraged at enterprise level
• Selecting/composing models requires specialized knowledge
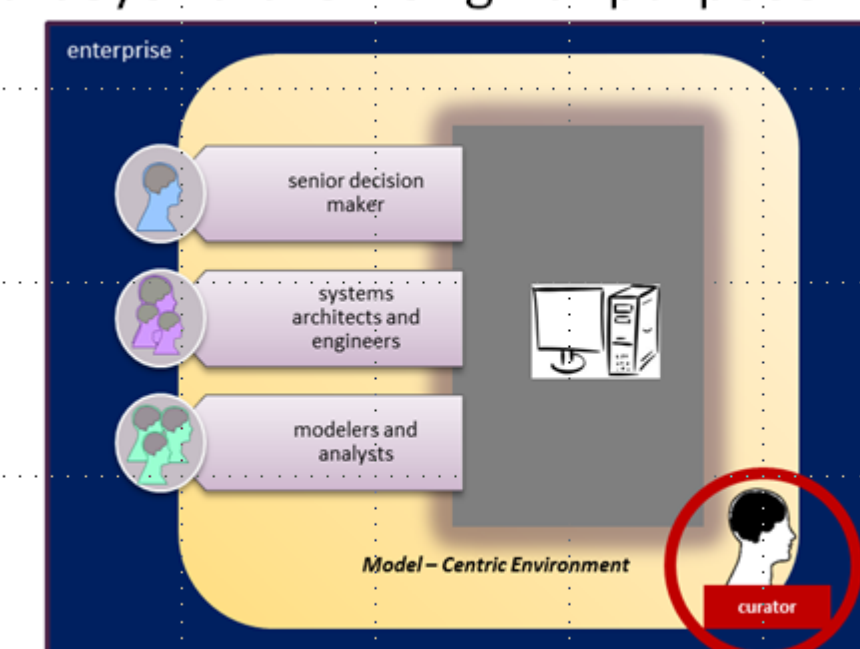
Humans need to be an integral part of the model-centric environment but largely considered as exogenous 'customers'

Research Question: How can visual analytics be used in system decisions involving complexity and large volumes of data?

prototype visualization tool
http://seari.mit.edu/ieea-single_epoch.html
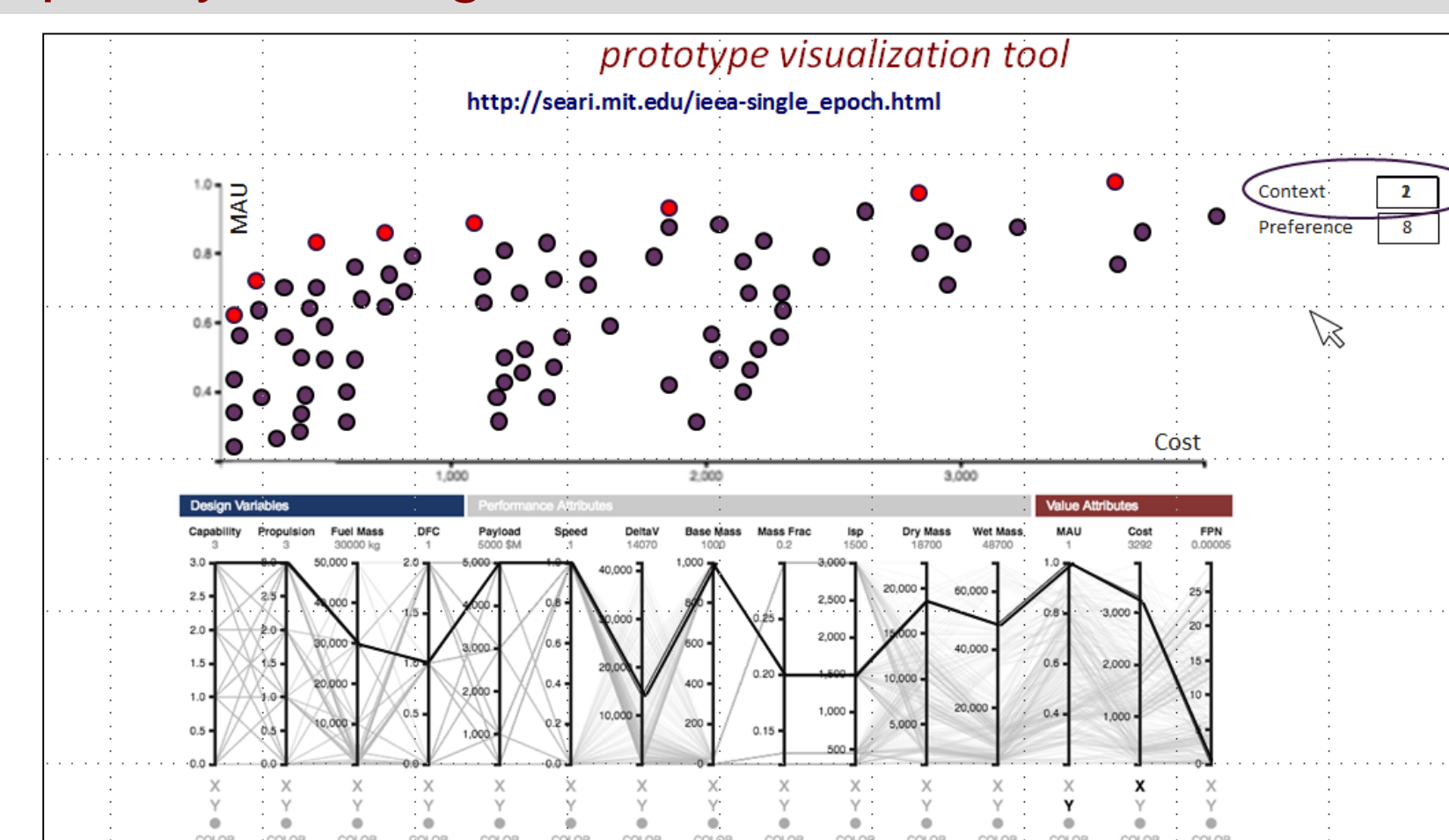
Ongoing research applies visual analytics to interactively explore the impact of changing context in tradespace exploration

Future Research

o Continue empirical investigation of model-centric decision making
o Conduct assessment of impacts of visualization and interaction using designed experiment
o Publish state of practice report on human-model interaction, with updated research roadmap
o Form partnerships to transition model curation research outcomes into broader community initiative
o Develop competency needs and architectural description for a human-model interaction learning laboratory

Contacts/References

Dr. Donna H. Rhodes, PI
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Research reports available on SERC website
Recent papers and prototypes available at seari.mit.edu

SERC TALKS

Upcoming Research Webinar

December 7, 2016

"Why is Human-Model Interactivity Important to the Future of Model-Centric Systems Engineering?"