



# Systems Engineering Research at Penn State

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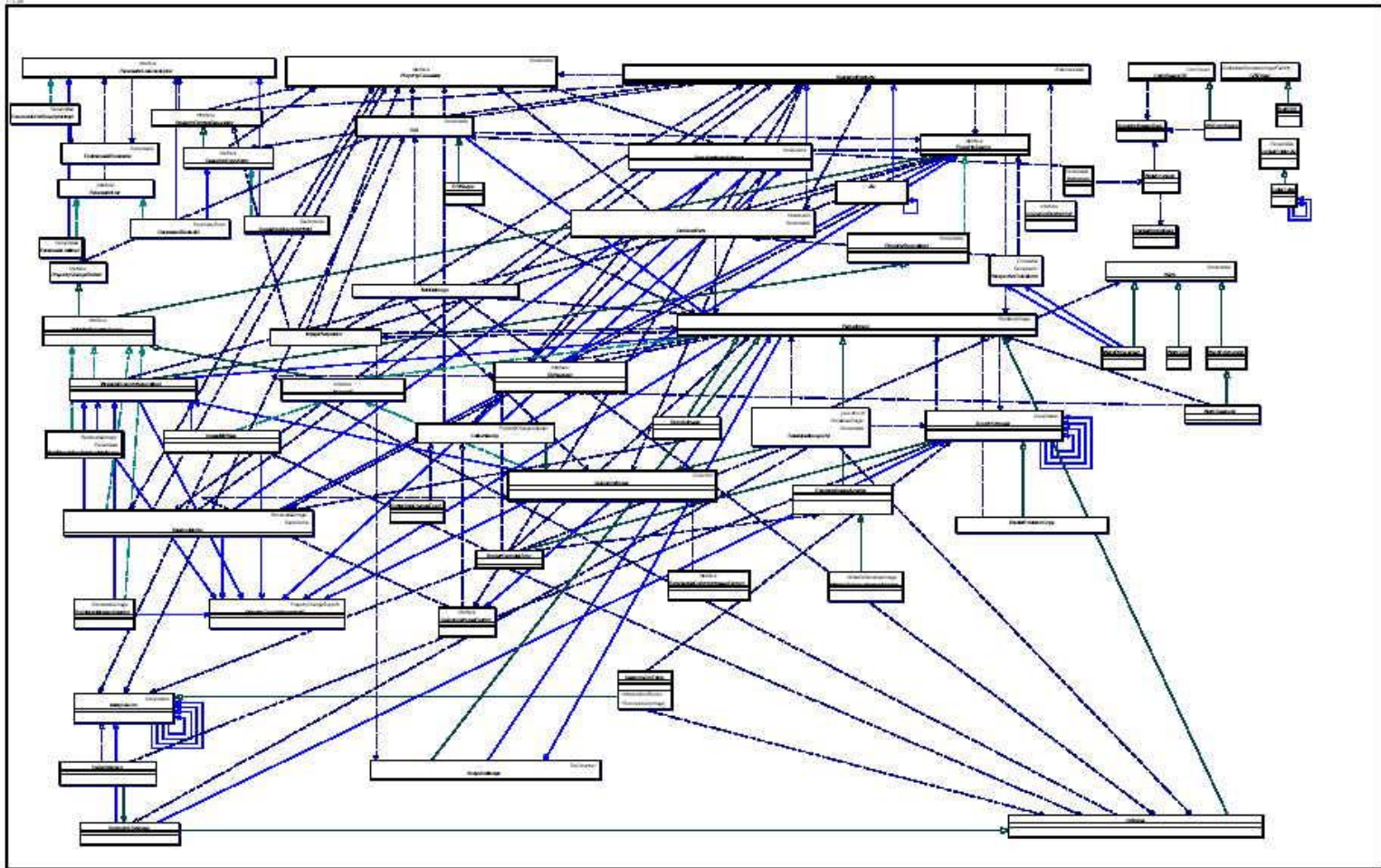


# System Architecture

- We have extensive experience in architectures of systems and systems-of-systems (evolution; complexity; quality; security)
- We research how ‘ilities’ manifest in architectures, and therefore how to design for them, reason about them, and detect their presence.
  - Recently completed a study of security requirements and evaluation of secure architectures. (we are members of the Network & Security Research Center at PSU).
  - Developed a design method that integrates architecture-centric design and OOA&D to ensure that critical systemic properties drive design decisions.
  - Developed a multidimensional approach to the study the evolution of architectures



# How can we help architects understand this?

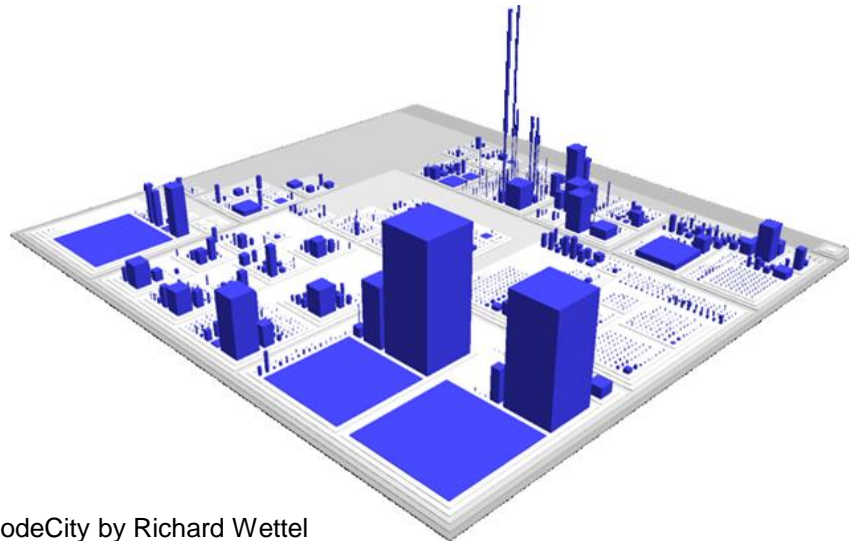


And simultaneously think about, and design for, security, resiliency, interoperability, extensibility, ...?

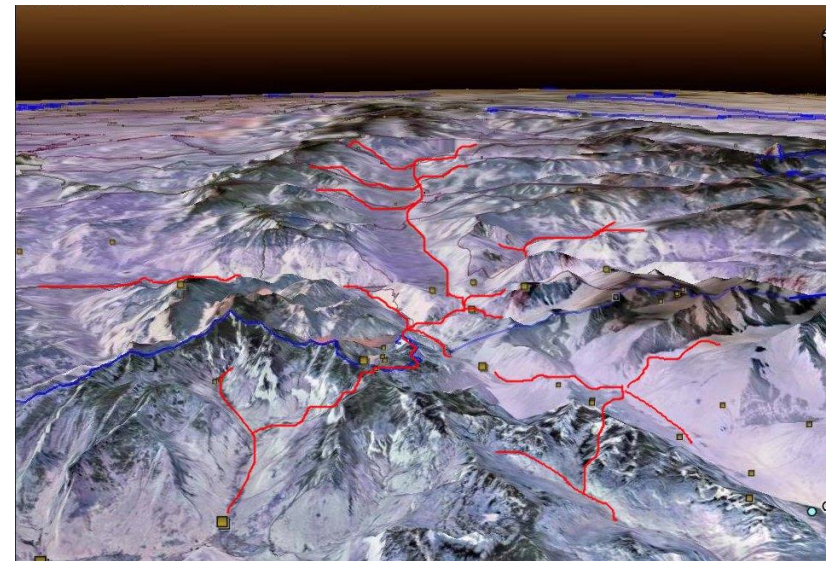


# Architecture-centric design

- Architecture fault-line visualization tools
  - We propose a tool that visualizes the entire architecture of a developing system as a “terrain” where fault-lines represent fragility in the system so that the full impact of proposed changes and updates to the system can be anticipated.



CodeCity by Richard Wettel

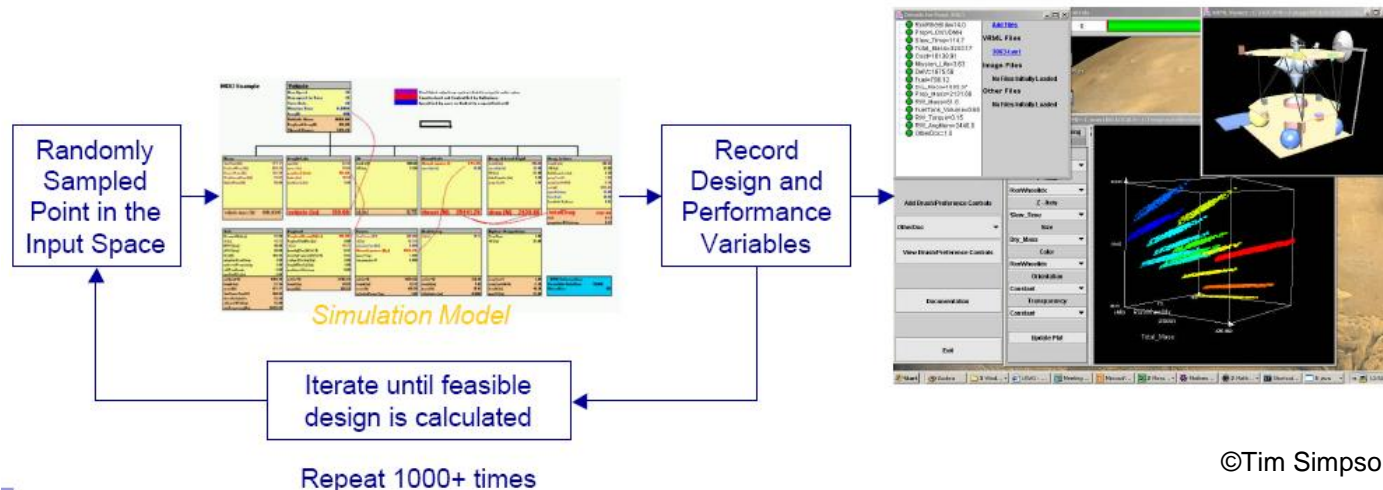






# Architecture-centric design

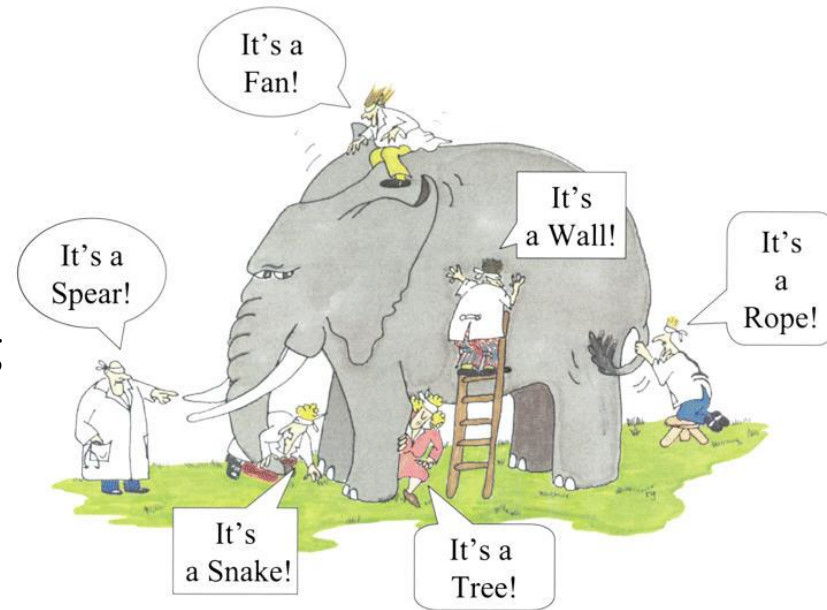
- Quality attribute tradespace exploration tools
  - We propose extending PSU's Advanced Trade Space Visualization (ATSV) system to allow architects to explore the trade-offs in quality attributes (security, accessibility, reliability, extensibility, etc) of design decisions.





# SE Workforce

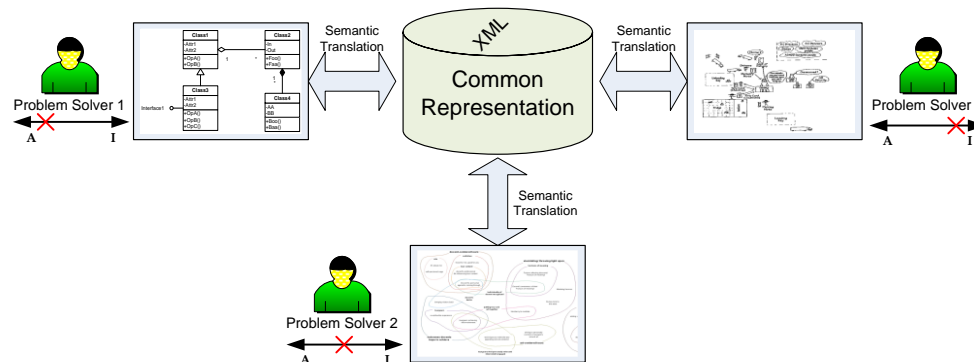
- Facilitating and maintaining team mental models
  - Investigating cognitive collaborative models that improve team performance by rapidly converging individual perspectives into a shared mental model of the problem and the solution.
  - Developing methodology for the elicitation, representation, and analysis of tacit mental models using concept mapping.
- Investigating the impact of cognitive diversity on teams, managers, projects, and outcomes.
  - Projects funded by PJM and AstraZeneca.
  - Proposals in to PMI and NSF





# Problem Solving & Design

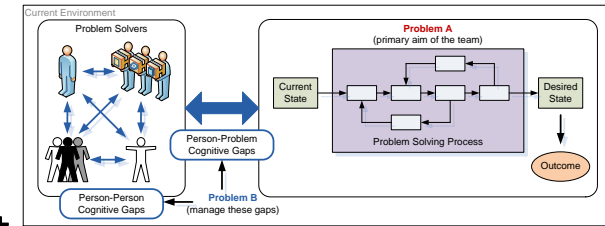
- Impact of problem solving style on design
  - Investigated the relationship between problem solving style, work/task preferences, and coping behavior within the design process. (pilot study with Rolls Royce design engineers)
- Cognitive Collaborative Design Tools
  - Suite of design tools that extend the capability of human creativity and problem solving by enabling teams of designers with diverse creative styles to collaborate with minimum coping behavior by supporting their individual cognitive differences.





# Computational Models of Leadership

- Developing a theoretical framework, and prototype implementation, of a multi-agent model of command leadership where leader and follower agents are characterized by four key cognitive variables: *cognitive style*, *cognitive level*, *motive* and *opportunity*.
- Applications include:
  - Decision support and leadership during the fight
    - Provide leadership guidance (commander's intent) to unit and team commanders.
  - Tactical leadership training
    - Allow leadership trainees to evaluate their performance in virtual situations and respond to the feedback.
  - Offensive planning
    - The detailed human, social, cultural, and behavioral model, supports increased fidelity of the Red Force social organization structure to aid in the prediction of impacts of changes in leadership in cellular organizations.





# Applied Research Lab

- A university center of excellence for defense science and technologies and DoD-designated US Navy UARC.
- Strength and leadership in the following research areas:
  - acoustics,
  - guidance and control,
  - thermal energy systems,
  - hydrodynamics,
  - hydroacoustics,
  - propulsion,
  - materials & manufacturing,
  - navigation & GPS,
  - communications & information
- Over 1000 faculty and staff
- Able to perform classified research.