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The Challenges of Implementing a Modeling Tool in the Intelligence Community

Infrastructure Interdependence Modeling:

How does the presence of uncertainty create risk in the application of Cranberry?

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Background

In February 2007, I accepted an Intelligence Community Postdoctoral Research Fellowship

- Partnership with Sandia National Laboratories, Director of National Intelligence and Central Intelligence Agency's Directorate of Science and Technology.
- Study how to incorporate Uncertainty Quantification methods into intelligence community, especially computational analyses.

Methodology

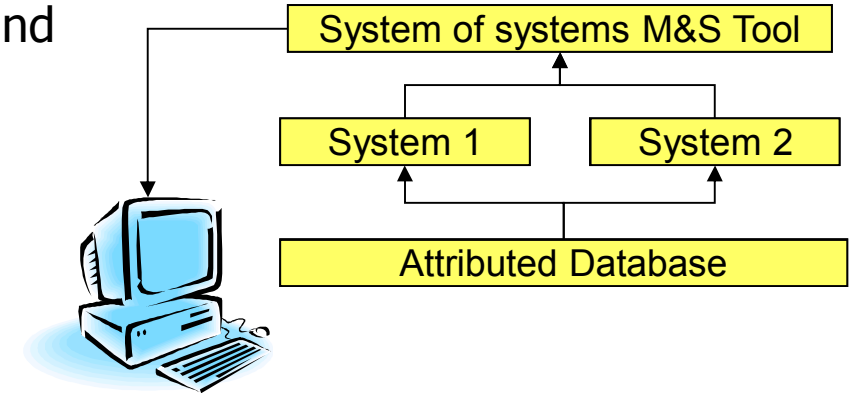
- Conduct extensive interdisciplinary literature review
- Interview M&S developers, potential IC users, and program managers
- Focus research attention on the IC users and their business practice
  - *previous research has disproportionately been paid to the mathematics and not the users' needs.*

Introduction

The intelligence community is *complex*, *heterogeneous*, *multi-disciplinary* and engaged in *high risk* work.

Cranberry is a collaborative modeling effort and software in the intelligence community that brings together a diverse group of people to achieve systems of systems analysis.

- Developers are senior intelligence analysts, software programmers, and engineers.
- Users are general intelligence analysts.



A particular application is infrastructure analysis. Users want to know how interdependency effects are propagated from one infrastructure to another e.g. social interdependencies and SCADA (Supervisory Control And Data Acquisition).

- Identify plausible outcomes
- Improve final judgment
- Reduce decision risks

Infrastructure

Infrastructure is a broad term that essentially describes the basic structure of a system that is necessary for the system to operate.

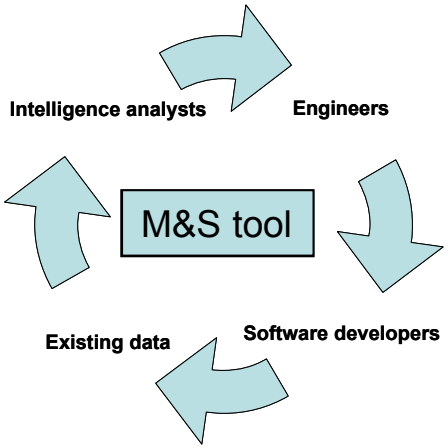
Specifically, Cranberry is interested in **Critical Infrastructures,** those country assets that are necessary for maintaining society.
For example, Homeland Security Presidential Directorate-7 defines 17 critical infrastructures and key resources:

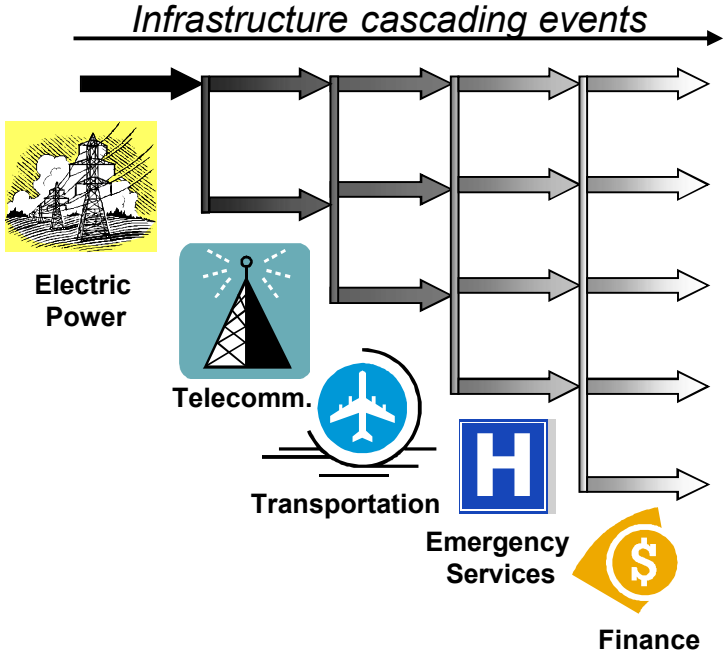
- Agriculture and Food
- Defense Industrial Base
- Energy (Electric, Oil, Gas)
- Public Health and Welfare
- National Monuments and Icons
- Banking and Finance
- Drinking Water and Water Treatment
- Emergency Services
- Telecommunications
- Postal and Shipping
- Transportation Systems
- and more

Case Study

The Cranberry developers are specifically interested in providing a good assessment of cascading events due to various infrastructures.

"Cascading" describes a chain of events through multiple infrastructure layers.





Simulate plausible infrastructure outcomes.

For example, electric outages causes dependent cascading effects to telecommunication, air transportation, etc. with compounding influences.

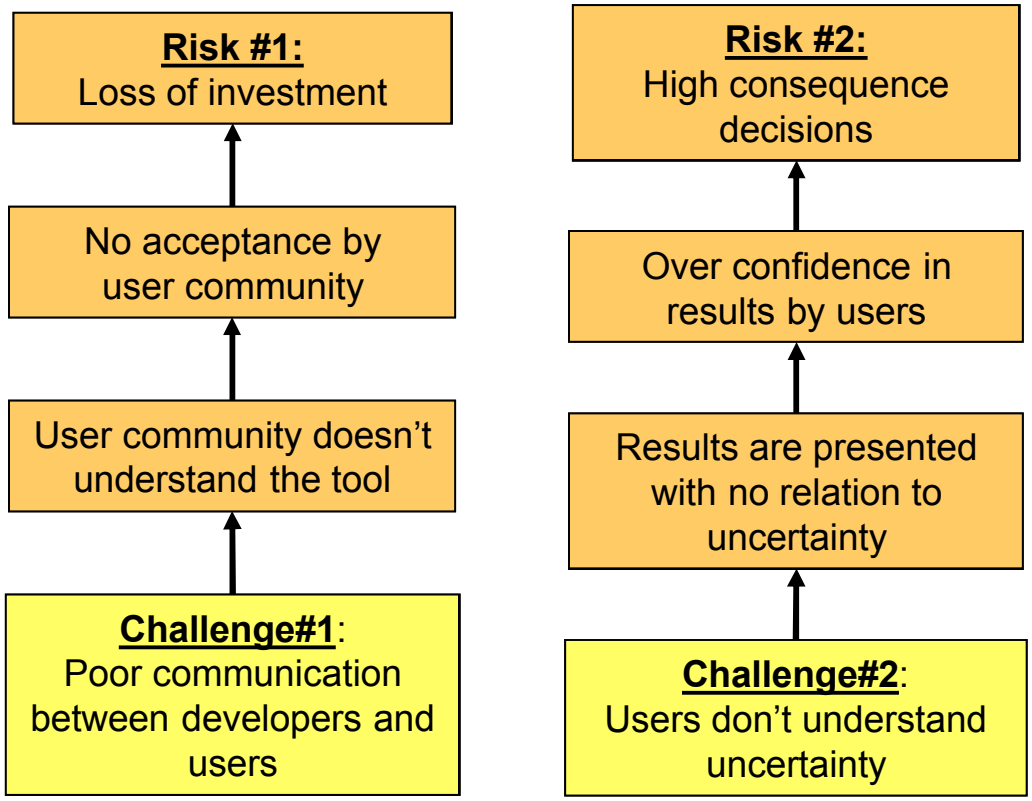
Case Study

Developers amplify the risks of implementing a new software tool by not accounting for uncertainty.

- Initially we were engaged to study the mathematics of uncertainty applied to Cranberry.
  - Uncertainty plays a significant role in the tool.
    - Sparse data, vague system states etc.
  - However, there are social aspects that override the mathematics of uncertainty in the development of the tool.
- We want to discuss two risks that are relevant to this symposium
  - Risk #1: Loss of investment
  - Risk #2: High consequence decisions

Analyst: *"I'm not a model guy. So this is new to me."*

Risks and Challenges



Lessons

- IC is unclear about
  - the value that uncertainty quantification provides
  - how to deal with uncertainty quantification organizationally
- Given a model, analysts are not clear about how the model can help their analyses.
- Analysts would not easily identify a helpful model from a set of alternative models.

Findings and Recommendations

Findings

- *Poor communication hinders tool progress.*
  - The developers were not committed to a common vision.
- *A rigorous elicitation procedure can help to focus the developers*.
  - There was no rigorous effort made to elicit information from intelligence analysts.
- *Uncertainty that is not conveyed in the model results leads to an inappropriate use of the model.*
  - Users didn't understand the role that the model could play in their work.
- *Uncertainty needs to be addressed concurrently with model development.*
  - Uncertainty was considered "after the fact" and some developers misapplied it.

Recommendations

- Explicitly define the vision for the project. Revisit this vision constantly.
- Use a formal elicitation process.
- Define the extent that uncertainty should be communicated in the model results.