The Use of Dynamic Stochastic Social Behavior Models to Produce Likelihood Functions for Risk Modeling of Proliferation and Terrorist Attacks

Presented at PSAM9
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20 May 2008

The objective is to address the need for predictive capability

- Estimate likelihood of future events
- Support decision making to:
  - Identify significant threats
  - Effective countermeasures
- Address both:
  - Technical aspects
  - Social/behavioral aspects

Research Goals

- Merge Domains
  - Combine predictive information from dynamic **technical** models with dynamic **social** models for critical infrastructure
- Merge Information Types
  - Combine predictive information from organized **expert** assessments (Judgmental Bootstrapping models), dynamic stochastic network (DBN) **models**, and **observations**.
- Transparency
  - Develop clear and understandable explanatory **diagnostics** for both Judgmental Bootstrapping and DBN **models** and for the **evidence** associated with the models in an **analysis.**

The challenges

- Difficulties in predicting likelihood of intentional acts
  - Resource dependent
  - Objective dependent
- Validity of results
- Interface between technical and social model

The interface issues

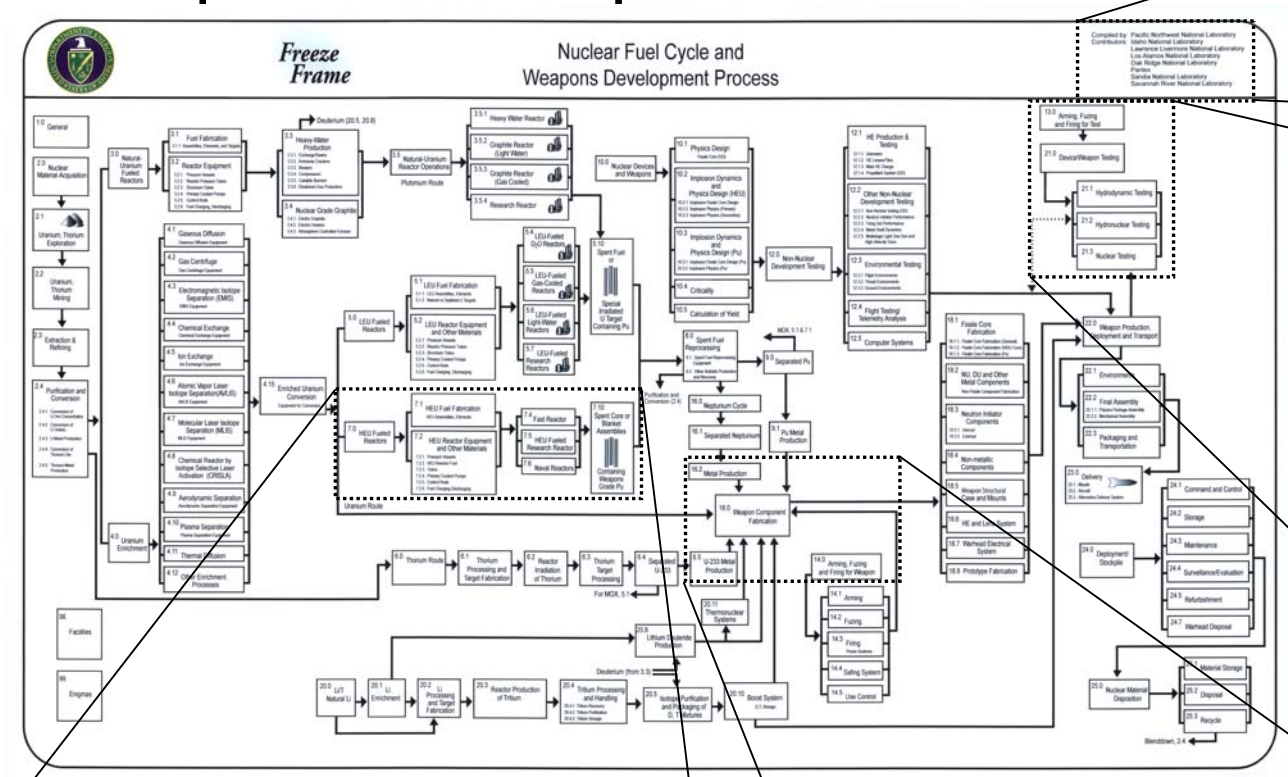
- Structural: In which model (technical or social) do events appear?
- Logic: What drives the logic of the model?
- Level of detail: Is the level of detail compatible between models? Which model (or data) drives the level of detail?
- How are the interfaces affected by the dynamic nature of the problem?

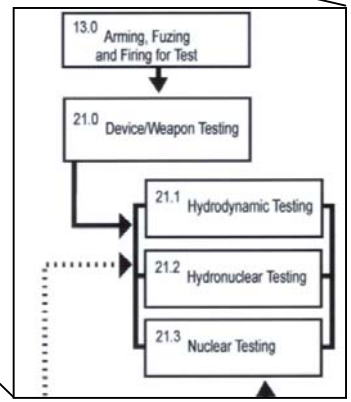
Scenario Setting

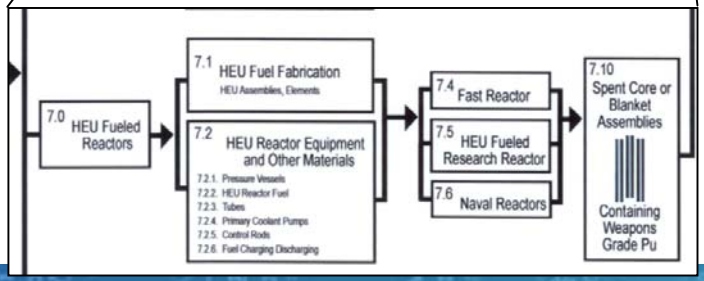
- (Notional) Reprocessing Fuel Facility
- Potential for material diversion
- Issues and models:
  - Social/behavioral - Insider motivations, groups
  - Technical – Internal security, safeguards, opportunities. Overall needs for materials (is nuclear material in hand? Where is the group in the process of obtaining a device?).

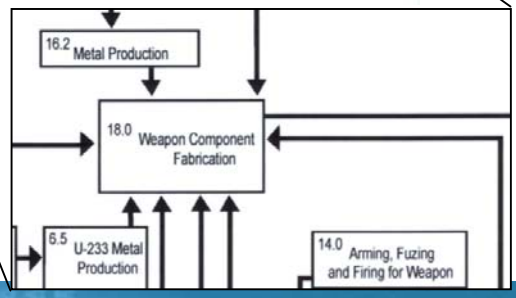
FreezeFrame – Process Flow Diagram for Nuclear Weapons Development

Compiled by: Pacific Northwest National Laboratory
Contributors: Idaho National Laboratory
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
Oak Ridge National Laboratory
Pantex
Sandia National Laboratory
Savannah River National Laboratory

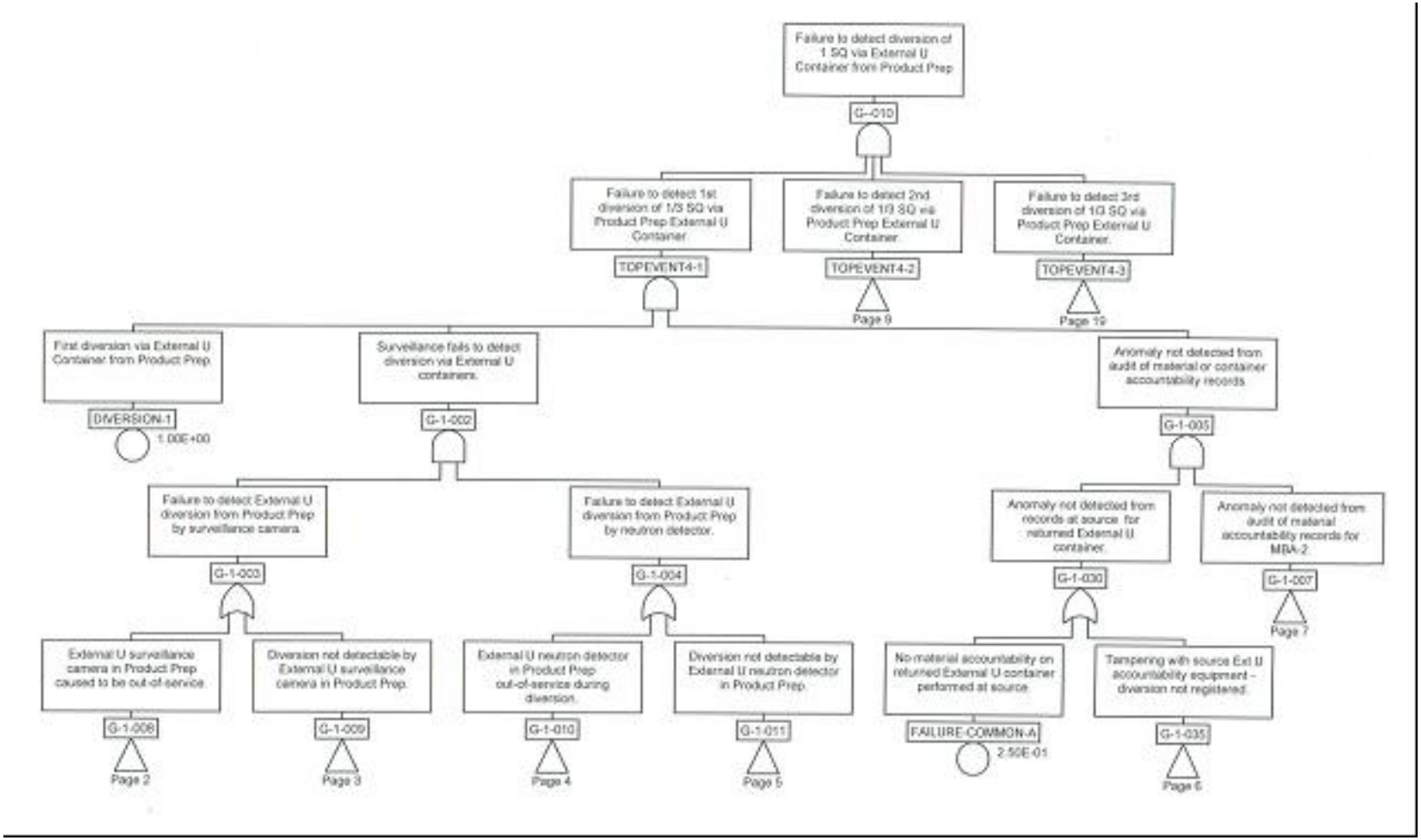




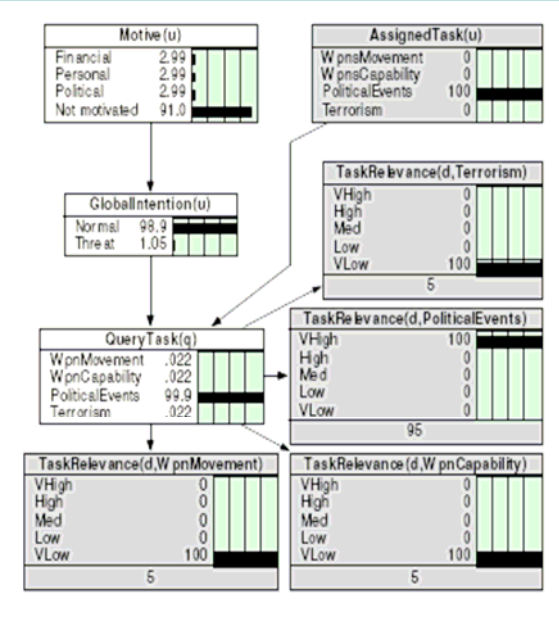




Material Diversion Fault Tree

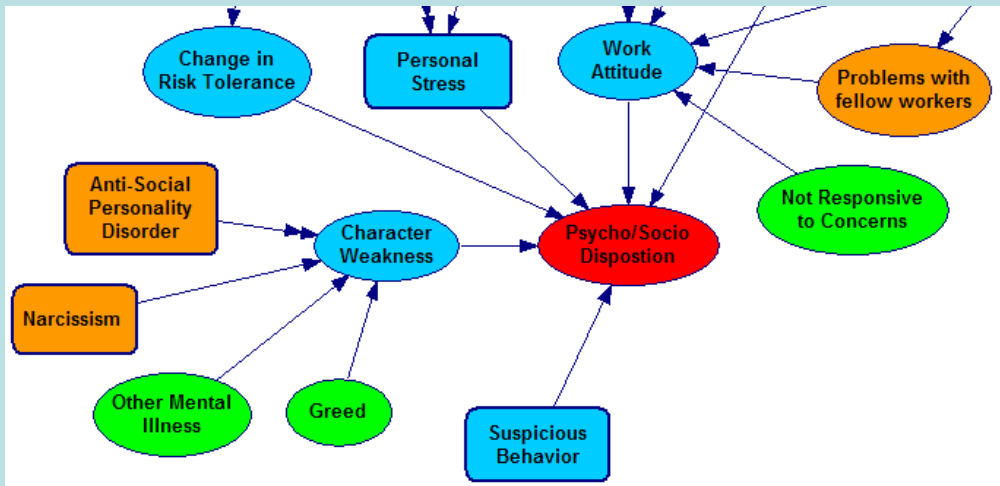


Behavior Models



Detecting Threatening Behavior Using Bayesian Networks – Laskey et al - Proceedings of the Conference on Behavioral Representation in Modeling and Simulation, 2004.

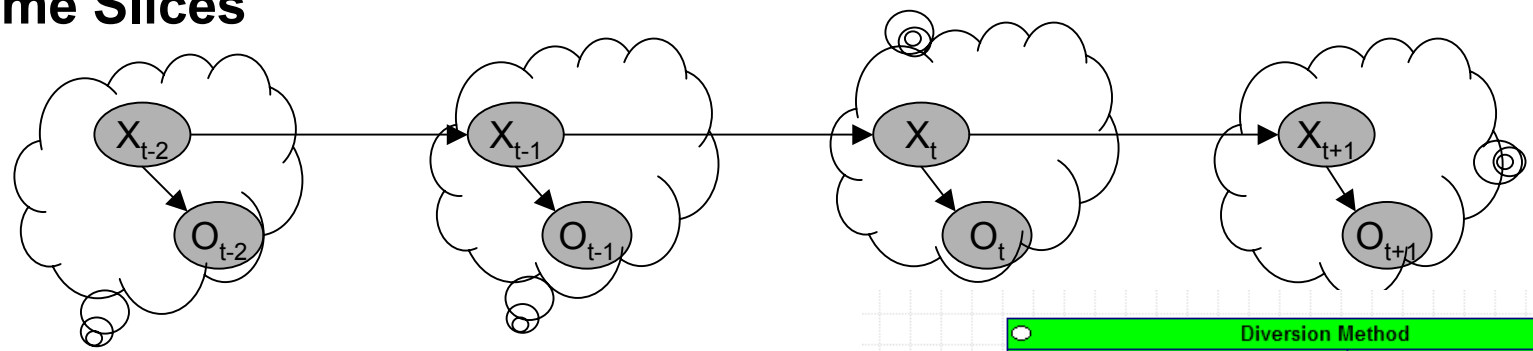
Influence diagram models of group behavior.



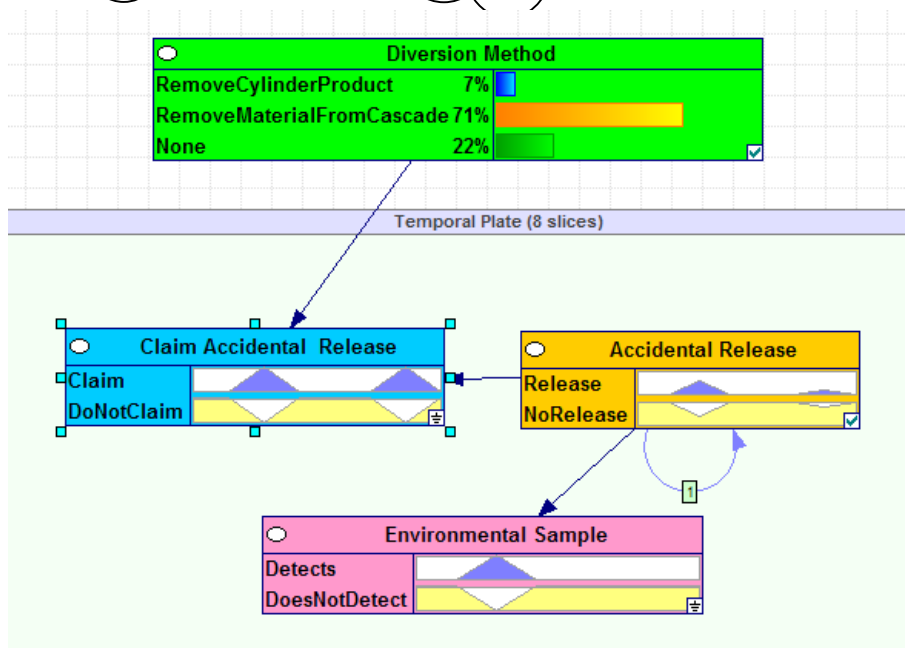
Behavior model fragment developed for insider cyber threat

Dynamics

Time Slices

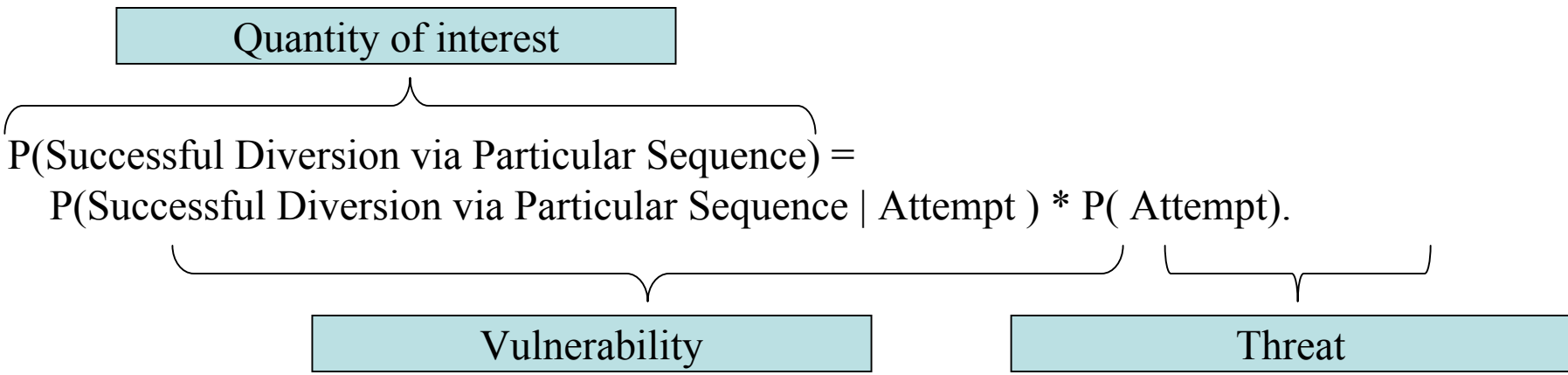


- All assumptions are easily changed. Values are for illustration only.
- Accuracy of Detector.
  - Assumes Sensitivity and Specificity are 90%.
- Diversion Method
  - Assumes diversion methods are equally likely and is their 6% chance of diversion in any time period.



Scenarios and Models

- Our expression of technical models (fault trees, event trees, possibility trees, process models) can also be accomplished as Graphical Models such as Bayes nets
- This is extremely convenient – we have similar expressions for Social/Behavior models



Judgmental Bootstrapping

Narrative setting:
You are a highly placed advisor to the ruling group of your country. You have been ordered to make a recommendation concerning a nuclear weapon development program given the following conditions:

- Your country has the capability to produce high-quality specialty steel.
- Your country has large deposits of uranium bearing phosphate ore.
- Your country has an advanced high technology industry.
- Your country has only a limited ability to withstand political ramifications (UN sanctions, trade embargoes, etc.) which may come with the disclosure of your nuclear weapons development program.

Please assign weights to the following outcomes, considered as policies to guide your country over the next year:

A. We should develop an overt peaceful nuclear program to hide a covert nuclear weapons development program.
B. We should develop a nuclear weapon with assistance from a friendly nuclear weapons state.
C. We should only develop a peaceful nuclear program.
D. We should not develop any nuclear technology.
E. Other (please explain)

Upcoming – Near Term

- Diagnostics – the R&D necessary to ensure transparency of modeling and analysis
- Detailed scenario calculations and demonstrations
- Mathematics relating Judgmental Bootstrapping with Stochastic Modeling Approaches

Longer Term

"Games are also an interactive laboratory with which models and simulations can engage. They can play the role in social and organizational modeling that linear accelerators play in particle physics—testbeds built and used to perform experiments and analyze results (Carley, Moon, Schneider, and Shigiltchoff, 2005). Like linear accelerators, MMOGs are expensive to build. The costs of successful immersive game development run from $8 million for the first two years of game development for a Spartan effort like America's Army to more than $100 million to develop a massive multiplayer online game and its infrastructure."

Behavioral Modeling and Simulation: From Individuals to Societies

Greg L. Zacharias, Jean MacMillan, and Susan B. Van Hemel, Editors, Committee on Organizational Modeling from Individuals to Societies, National Research Council

ISBN: 0-309-11863-8, 400 pages, 6 x 9, (2008)

This PDF is available from the National Academies Press at:
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Questions?