Live and Computational Experimentation in Bio-terror Response

Alok Chaturvedi
Purdue Homeland Security Institute
Krannert School of Management
Department of Computer Sciences
Purdue University
West Lafayette, IN, USA

TEAM

- PI: Alok Chaturvedi,

- Purdue University, West Lafayette, IN, USA
- Naval Postgraduate School, Monterey, CA, USA
- Indiana University, Bloomington, IN, USA
- Simulex Inc.
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Simulex Inc.

PHSI’s Structure

5 Centers of Excellence established

- Resilience
- Energy
- Advanced Manufacturing
- Learning
- Cyber
- e-Enterprise
- Sociotechnical Science
- Humanitarian Security of Large Scale Systems

Purdue Homeland Security Institute
Computational Homeland Security
Security of Large Scale Systems
Sensing Science & Technology
Military and Law Enforcement TTT
PURVAC
Overarching Goals

• Establish a network of homeland security professionals in industry, government, and academia
• Raise awareness of vulnerabilities and proactive/reactive procedures
• Measure and better understand the impacts of decision making in a virtual scenario

General Approach

1. Collect economic, public health, and food distribution data
2. Develop computer model
3. Establish teams representing food industry, government, media, etc.
4. “Play” the simulation
5. Facilitate discussion of decision making rationale with after action reviews
SEAS-VIS 2006 Capabilities
Multi-layer, Multi-Granularity, Effects Based

SEAS VIS is a representation of 40 countries with "validated" models (well accepted, published in peer-reviewed journals)

Represents
- Political Nodes
- Military Nodes
- Economic Nodes
- Social Nodes
- Information
- Infrastructure

100 Million Active Agents

Effects Based Operation

- Observe the achievement level of each Effect over the past 10 days
- Select node to act upon to increase the achievement of an effect
- Select one or more actions to impose on the node to achieve this effect
- Set the amount of resources to utilize for this action over 10 day period
Create a synthetic environment consisting of nodes* from the Real World..

Nodes
• Citizen
• Organizations
• Institutions
• Infrastructure
• Media
• Governments

Theories
Open Source
Achieves & Databases:
• Historical
• Live
• Synthetic

Multiple Perspectives

*Any object of interest -- contains traits, behavior..

Model Development

• Synthetic Environment for Analysis and Simulation (SEAS)
  – Agent based modeling environment
  – Epidemiology
  – Media and public opinion model
  – Economic and social network models
  – Food Supply chain
Data Collection

• Information type (examples)
  – Economic data (retail prices, market share, recall effects, cost of testing)
  – Public health data (biological and chemical agent characteristics, foodborne illness statistics, etiological agent testing, infective dose, morbidity/mortality rates, intervention strategies)
  – Ingredient and food distribution data (processing plant locations, production information, product information, distribution networks)

• Accessing information
  – Literature searches, company financial statements, personal communication

Simulation Teams

• Human Players - Make Decisions
  – DHS, HHS, DOT
  – Ingredient Suppliers
  – Food Processors
  – Food Retailers
  – Food Transportation/Distribution

• Human Players – Provide Information
  – Government (DOD, USDA, FDA, CDC, FBI)
  – Homeland Security Institute
  – Media

• Computer Players:
  – Food Distribution
  – Game Master
Playing the Simulation

• Before
  – Teams established day before simulation, training session, simulation manuals

• During
  – Each team localized into separate room, 11 rounds from day 9-20, after-action review after 3-4 rounds

• After
  – After situation review, survey instrument

Simulation Setting
After Action Reviews

• Designed to:
  – Understand the rationale of decision making for each of the teams involved
  – Understand the economic and public health impacts of decisions
Following a Scenario

• Day 9
  – An increase in foodborne illness with Hepatitis A and Staphylococcus poisoning noted in California

• Day 10
  – Hepatitis A, Staphylococcus poisoning, and Salmonella increase throughout country
  – 1/4 processors began testing for these agents

• Day 11
  – CDC reports 38,000 ill, 1 dead (staph toxin)
  – Foods: toast, breakfast cereal, milk, juice, coffee, yogurt, bagels, and cream cheese
  – 2/4 processors have ongoing testing

• Day 12
  – National media reports 5 more deaths
  – 4/4 processors now have ongoing testing
  – Terror alert raised to level orange
Following a Scenario

• After Action Review I
  – All processors made error and tested for presence and level of *Staphylococcus aureus* vegetative cells rather than the toxins it produces – assuming live organism was present

• Day 13
  – 51,000 ill, 13 deaths
  – 5000 products tested - suspect food identified: refrigerated dairy beverage from processor D

• Day 14
  – Processor D voluntarily recalls $165 million worth of suspect product
  – Retailers recall all products and ask for help to determine possible links – manufacturers comply
  – 4/4 manufacturers increase testing of products
  – 4/4 manufacturers begin testing of ingredients
Following a Scenario

• Day 15
  – 2 more people die due to staph intoxication
  – No more illnesses reported

• Day 16
  – 15% of processor C product (hot dogs) found positive for staph toxin
  – Processor C asked retailers to put product “on hold” – retailers responded by fully recalling product

• Day 17
  – 2 more deaths reported and many illnesses
  – Identified foods: soda pop, juice, ham, hot dogs, turkey, soup, chili, and burritos

• Day 18
  – Processor C recalls ALL hotdogs nationwide at a cost of $480 million
  – Retailer A identifies that ascorbic acid is common ingredient in both products
  – Test results from processor C find ascorbic acid from Ingredient A supplier was positive
Following a Scenario

• Day 19
  – CDC and FDA report that common contaminated ingredient was ascorbic acid from ingredient A
  – Products containing this ingredient from ingredient A supplier identified
  – Total death toll now stands at 30
  – Ingredient A supplier refuses to accept blame
  – Retailers A, B, and C join forces not to accept any products that have ingredients from Ingredient A supplier

Following a Scenario

• Day 20
  – FDA and CDC issued their final press release before simulation play ended: “Contaminated Vitamin C used in Processor C’s hot dogs has been identified in the Michigan plant. Vitamin C has been traced back to Ingredient A.”
  – Processing was halted at both food processing plants pending further investigation
  – Retailer A provides statement to NEVER accept product from Ingredient A
Scenario: What Happened?

- Terrorists contaminate 2 lots of ascorbic acid with heat stable acid resistant staph toxin
- Ingredient was used in refrigerated dairy beverage (short shelf-life) from Processor A and hot dogs (long shelf-life) Processor C
- Illnesses and death rates calculated from CDC data, food distribution data, and consumption patterns

Scenario Impacts

- Possible Effects
  - 1.5 million illnesses
  - 1000 deaths

- Actual Impact
  - 55,000 illnesses
  - 30 deaths
  - $645 million recall costs
Lessons Learned

Decision Making

• Current organizational structures are not designed for optimal performance in homeland security
• Affiliation factors drive decision making in early stages over situation needs
• Over time, as uncertainty decreases and information on the situation increases, affiliation goal drivers dissipate and situational needs drive decisions.
• Magnitude of situation needs may overpower affiliation effects.
• Outcome based learning lessen effect of affiliation goals in decision-making.
Communication

- Communication up and down the chain is critical and challenging
- Media plays an important source of information (misleading information impacted simulation)
- Lack of guidelines, common vocabulary, and standard operating procedures

Risk Analysis

- Reliability and import of available information
- Immediate versus delayed disclosure
- Level and extent of disclosure
- Intensity of intervention
- Short term versus long term political and economic impact
Decisiveness and Timeliness of Actions

- Clarity in selection and acceptance of decision maker
- Decision makers need to be trained to be decisive and take timely actions
- Responders must have adequate technological support available at all times
- Synthetic environments are valuable for all levels of decisions and implementing actions

Coordination

- Mutual aid agreements across state lines are needed
- Mismatch exists among the industry, elected officials and responders
- Improved definition of roles of different agencies and the support material, information and technology
- Reduction of decision cycle time
Early Warning

- Information flow
  - Need for a policy and mechanisms for a streamlined flow of information within and across levels of decision makers and responders

- Early Detection
  - Lack of support for situation assessment and decision making
  - Need for a closer coordination between responders and technical experts
  - Need for better surveillance systems and data fusion environments

- Linking the real and virtual environment for analysis, early warning, and training

Human Resources

- Procedures should be put in place for new hires including in-depth background checks, character evaluations, and performance surveys

- Policies for dealing with disgruntled employees should be updated to include their threat to bioterrorism as well
Current and Future Work

CBRNE Modeling

- Realistic modeling of base protection scenarios covering CBRNE
- Impact on base operations if community is disrupted
- Quality of Service Guarantees
- Overlay of plume models, epidemiological models

Future
- Add weather models to the society
- Add traffic and evacuation models
Evacuation Modeling and Visualization

Agent Evacuation at 2 seconds after alarm
Agent Evacuation at 18 seconds after alarm

Scalability: from an Individual Building to a City
Mixed Reality Environment

Real buildings virtually placed on real terrain for live exercises with real people and real equipment, but fictitious scenarios.

Virtual International System

Synthetic Environments for Analysis and Simulation (SEAS) is a Computational Experimentation Environment that is:

- Theoretically validated, behaviorally accurate, lightweight virtual agents for detailed oriented behaviors
- Allows human in the loop experimentation for strategic interaction
- Detailed environment modeling for interaction and situational context
- Emergent agent-agent and agent-environment interaction
Towards Hi-Fi Mixed Reality Environment

1. SEAS Agent-based Models
2. Live and Computational Simulation Bridge
3. DDDAS Science-based Models
4. Environment Manger (EM) Mode
5. Process Models
6. Live + Scenario
7. Database Models
8. Consequences Measurement Idea
9. Change in ONA

- JSF
- JWARS
- JCATS
- OneSAF
- SIM events fed into SEAS
- SEAS influences actions in other Sims
- ONA change populated in SEAS
- SEAS actions fed back to ONA
- SEAS Agents carry out new behaviors
- Agents access WebFountain Black Light for information
- Web Services
- Change in ONA
- Human Model Behavior modified by information
- Red indicates SPP Environment

Sentient World Simulation
Exemplar-Idea-Draft

Human Model Behavior modified by information

- Agents spawned for information related to change
- Agents access WebFountain Black Light for information
- Change in ONA
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Questions?

Alok Chaturvedi
alok@purdue.edu

Purdue Homeland Security Institute
www.purduehomelandsecurity.org

(765) 494-9793
Purdue University
West Lafayette, IN, USA