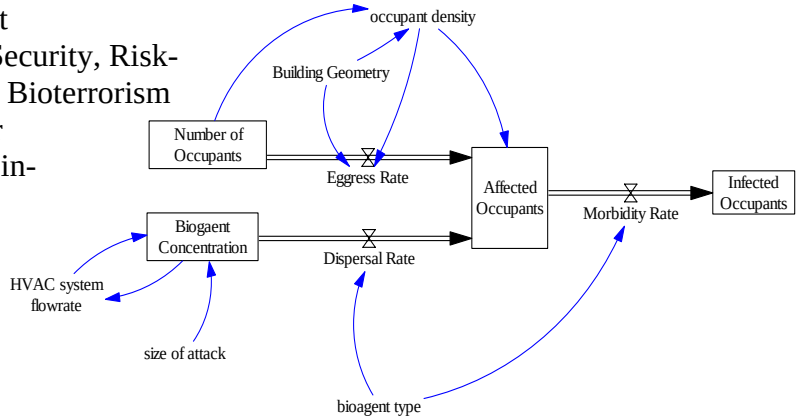
Project 13b: Resource Allocation in the Context of Bioterrorism (Bier)

This work will explore the use of system dynamics and performance-based design for allocating security resources among different types of buildings in the context of bioterrorism.

Modeling Area: Risk Management
Application Area: Infrastructure Security, Risk-based Resource Allocation, Bioterrorism
Principal Investigator: Vicki Bier
Institution: University of Wisconsin-Madison
Other Investigators: Larry Bank
Student Research Assistants: Ben Thompson



Simple building system interaction diagram for a bioterrorism case study

Brief Description:
We will explore the use of system dynamics simulations and performance-based design for allocating security resources among different systems and security upgrades within a single building, as well as among different types of buildings (e.g., to ensure that greater resources are allocated to higher-risk and/or more critical systems or buildings). The method will be illustrated with a case study involving release of a biological agent into the ventilation system of a building. The methodology will be applicable to both retrofitting of existing buildings, and to design of new construction.

Objectives:
The goal of this research is to expand the existing tools and techniques for building design to more effectively address security considerations.

Major Products and Customers:
A Building Simulation Interaction Model (BSIM) methodology for allocating resources amongst building systems and different buildings utilizing techniques for performance-based design that could be used by facility owners or managers in the public and private sectors.

Interfaces to other CREATE Projects:
This project is closely related to the case study on resource allocation, and is supporting the case study on bioterrorism. It also relates to the work being done on critical infrastructure protection.

Technical Approach:
The goal of this research is the development of a methodology for the application of a building system interaction model (BSIM) analysis to building design decision-making problems. The specific goal is application of the methodology to bioterrorism-resistant building design. This will be accomplished through a case-study involving bioterrorism threats to a sample building. This methodology will be generalizable enough to allow the model to provide information relevant to a wide range of hazards, both natural and manmade, in the future. The model will

take into account the interaction amongst various building systems, and determine the behavior of the building as a whole.

Work will be undertaken on the incorporation of both risk analysis and risk perception in performance-based design, in the context of bioterrorism-resistant design for integrated building systems. A simulation tool, such as Vensim (by Ventana Systems) will be used to model the interactions between various building systems and the perturbations caused in those systems by terrorist attack scenarios. Resource allocation will be addressed using the BSIM in two ways: (1) by varying levels of protection of various systems or components of a building, it will be possible to determine which components or systems are most vital to protect, and thus where resources should be directed within a building; (2) by varying building type or layout in the model, it will be possible to determine which types or configurations of buildings are most vulnerable to various attack scenarios, leading to a rational method for allocating resources amongst various buildings. The work will proceed using a case-study approach, involving a case study of a bioterrorism attack on a building. This will involve modeling of interactions among systems such as the mechanical (ventilation) system, electrical system, egress system, building envelope system and architectural (interior spaces) system.

Major Milestones and Dates:

1. Develop simple relational base simulation model for building systems (November 2006).
2. Begin characterization of relevant building systems (beginning November 2006).
3. Complete and submit for publication a review paper on the use of system dynamics applied to civil engineering and particularly to buildings (January 2007).
4. Characterize terrorist threats to buildings in terms of severity and likelihood (March 2007).
5. Begin characterization of a biological attack on the mechanical systems (air supply) of a building for case study (beginning May 2007).
6. Support work on case study of a biological attack being done at the University of Southern California (as required).