A. Project Summary

The project develops a Cellular Automata (CA) model and associated prototype software for the simulation of environmentally-constrained and managed pedestrian motion during normal times and during emergency situations that result in evacuations. The model captures naturally occurring interactions involving the environment, the pedestrians, physical constraints, emergency constraints, and the evacuation policies and controls that a management authority would attempt to implement.

i) Intellectual Project Merits

From a social science perspective it is useful to think of evacuation behavior during emergencies as having three distinct analytical dimensions: the physical environment being evacuated, the managerial policies and controls deployed at evacuation, and the psychological and social organizational factors impacting the people present during the emergency. It is much more common in the physics and engineering literature to find consideration of the first two dimensions than of the third. The proposed study addresses the essence, and the interactions, of all three dimensions of the pedestrian evacuation problem to predict the course of events following the enactment of specified evacuation policies and controls. As suggested, it reflects as well as advances the integration of several disciplines. The study aims to realistically meet the following goals:

1. develop a computerized approach to the social behavioral analysis of films of pedestrian flows, under emergency evacuation and non emergency scenarios;
2. provide the ability to compute pedestrian shortest paths within a hazard-constrained environment for varied sizes and spatial distributions of hazards;
3. provide the ability to model and to anticipate pedestrian behaviors under various emergency evacuation and non-emergency scenarios;
4. advance the state-of-the-art in pedestrian evacuation simulation by addressing all of its three dimensions through a concerted multi-disciplinary effort;
5. provide the ability to process semantic data streams within a pedestrian micro-simulation model;
6. develop a micro-simulation tool of pedestrian flow dynamics that takes into account all three dimensions of the pedestrian evacuation behavior, pinpoints evacuation flow bottlenecks, and predicts the average and maximum evacuation times, the pedestrian volume to evacuate over time, and the completion times of normal pedestrian movement;
7. enhance the understanding of collective behavior through simulation, thereby providing a much needed link between the disciplines of computer science, engineering, and the social sciences.

These goals mandate research spanning the three previously cited disciplines; namely video capture and analysis of pedestrian films, emergent individual and collective social behaviors, hazard-constrained path optimization, and incorporation of emergent behaviors into transportation routing and localized flow models.

ii) Broader Project Impacts

The project results will be interpreted in light of accumulated knowledge on the sociology of disasters, allowing for the provision, to local and federal government agencies as well as private organizations, of a useful blueprint to follow during crisis evacuations. This provision of guidance is an important benefit to society, as it improves disaster response programs at the local, state and federal levels. The need for a social science study of crisis evacuation is particularly keen nowadays as terrorist threats have increased. Project conduct entails the training of graduate and undergraduate students in the mastery of analysis approaches and the participation of female and minority faculty in science. Project results further facilitate consideration of evacuation in the design phase of architectural, engineering, and urban design studies. (T. F. Greene Airport in Providence, Rhode Island, is the proposed simulation test-bed. The Rhode Island Airport Corporation vouches for its strong support of the proposed effort and anticipates using the derived simulation software.)