

# *Tech Brief*

## **Technological Advances in Evacuation Planning and Emergency Management: Current State of the Art**

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### HERE'S THE PROBLEM

Evacuation of people in the event of hazard is one of the basic problems of human society. The complexity of human built buildings and infrastructures, as well as population density, has grown. This has increased dangers imposed by any hazard occurring in densely populated areas and has imposed higher requirements on evacuation and emergency management practices.

### AND, HERE IS THE SOLUTION...

To develop a resource of best practices and technologies for developing an evacuation planning and emergency management protocol, using civil engineering sciences for safe facility design and optimization of rescue efforts.

### BUT, HOW CAN IT BE DONE?

By reviewing the latest achievements in fundamental and applied disciplines, such as Simulation, Process Control, Applied Mathematics, Psychology, Architecture, and Physics in a survey of approaches and technologies being developed and used for Evacuation Planning and Emergency Management.

### THESE ARE OBJECTIVES OF THE STUDY...

- To classify developments in Hazard Safety by various factors, such as approach, technology, and methodology.
- To explain Evacuation Planning through various solution methodologies.
- To explain Emergency Management through various solution methodologies.

AND, HERE'S WHAT WE DID...

By approach to hazard management problem all methods may be divided into two main classes: Evacuation Planning and Emergency Management. Evacuation Planning employs proactive approach to problem solution by modeling the hazard occurrence process via various kinds of simulation techniques and develops recommendations for improvement of evacuation procedures: building plan redesigning, creating additional shelter areas, evacuation training, etc. Emergency Management deals with the hazard upon its occurrence, i.e. uses reactive approach. Its goal is to optimize the evacuation process and the efforts of rescue teams, such that number of casualties is reduced maximally.

By problem solution methodology, hazard safety methods may be divided into following categories: simulation, training and communication. Having the same goal of minimizing human casualties, hazard safety methods attempt to achieve via different routes. Simulation methods model real-life hazardous situation using collection of various mathematical methods, such as human behavior models, hazard propagation models, etc. Due to heavy computational requirements and long run times, simulation methods are mostly used in planning stage, e.g. helping architects to plan building such that human casualties are minimized in case of possible hazards. Training methods are used to educate people how to behave in emergency situations, how to coordinate their actions and evacuate the building in safest manner.

Communication methods provide efficient and reliable communication between rescue agencies. Customized to given evacuation environment, they attempt to coordinate efforts between rescue agencies, such that emergency situation is relieved with minimal losses. Clearly, communication methods have purely reactive, i.e. emergency management, application.

EPlan was designed by emergency management professionals. EPlan is a web-based collection of references, such as evacuation plans, mitigation plans, governmental safety regulations, building safety codes, etc. EPlan takes the user through hundreds of references with the click of a button, thus making the process of creating and updating the evacuation plan simple and quick.

BTG's Research Planning business unit (RPI) provides domestic preparedness services that focus on the actions needed to protect public health and safety, restore essential services, and provide emergency relief to affected individuals, businesses, and governments. From emergency management and planning to consequence management and counter-terrorism, RPI assists local, state, and federal governments, and clients in the private sector to deal with potential natural, manmade, and technological disasters, including those involving weapons of mass destruction.

Simulation is the main tool to reproduce the hazardous situation using computer technology in order to assess dangers and produce set of recommendations for evacuation procedures or alteration of environment, such as building layout changes,

creation of shelter areas, etc. Since it requires only the plan or the map of the premises (building, town, etc.), simulation is a great tool to assess hazard risks and consequences at planning stage. By using simulation, architects and city planners can update their plans before an actual construction occurs, thus increasing their safety and saving costs on remodeling.

EXODUS is developed by Fire Safety Engineering Group (FSEG) of the University of Greenwich, Greenwich, UK. EXODUS can be named the best fire evacuation simulation tool currently available in the market and features very sophisticated fire and smoke propagation models, as well as complex human behavior models. EXODUS currently comes in several versions: buildingEXODUS, marineEXODUS and airEXODUS.

Oak Ridge Evacuation Modeling System (OREMS) is developed by Oak Ridge National Laboratories and is a traffic simulation system, which aimed to be used to help emergency responders develop plans for moving people quickly and safely away from the site of most any disastrous event. Evacuation scenarios can range from a natural event, such as an earthquake or hurricane, to a deliberate attack on part of our energy infrastructure, to an accidental release of hazardous materials.

PedGo is a software tool, used to simulate evacuations of pedestrians, developed by TraffGo, GmbH, Germany. PedGo was a result of implementing the scientific results into user friendly and fast software. PedGo is claimed to be the fastest program to simulate evacuations available on the market (10.000 Persons in real time on a 500MHz PIII). As a result, it saves valuable time to do many evacuation runs, which are mandatory for statistical evacuation analysis.

The Assisted Evacuation Simulation System by Takenaka Co., Japan, is designed to simulate evacuation of patients and personnel in environments, where some people are not capable of evacuating themselves. Hospitals and Assisted Living Facilities are examples of such environments. This system can be used not only for new facilities, but also in the renewal plans of existing facilities and review of disaster prevention management frameworks of hospitals.

The **SEV**eso **EX**pert system or **SEVEX** is a software designed to estimate risks zones around hazardous materials handling and storage facilities like chemical activities, in particular the "Seveso-type " industries (*cfr. the European SEVESO Directives*), railway marshalling yards, ports area or pipe-line terminals (*cfr. announced European Directives*).

Training is an important part of preparing for emergencies. Two types of training may be identified. First is the basic training, which all employees should receive some training when they initially begin work, when they change work areas within the organization, when procedures and/or hazards change and periodically during their employment. Second type is more specific and extensive training, provided to personnel who have specific responsibilities under the plan.

Simulators are artificially-built facilities, which replicate the real-life emergency environment with high degree of reality. For instance, aviation evacuation simulator is an

exact replica of a airplane segment, allowing flight crew to practice passenger evacuation in maximally realistic conditions. Due to impossibility to use simulators to train common personnel, alternative ways of training are being investigated.

A-TEAM is an IT firm in Austria, working in the field of development of e-Learning tools for Safety Education and Training. The main objective of the A-TEAM project is to improve the learning process in complex, technical domains, using the example of technological emergency management.

High Level Architecture (HLA) is a simulation interoperability standard currently being developed by the US Department of Defense (DoD 1996). The key features of HLA are:  
 1) Communication is about objects, their attributes and interactions between objects and  
 2) Documentation standard specifies the object hierarchy, attributes, and interactions both within each simulation, or federate, and the set of federates, or federation.

E Team, Inc. provides enterprise-level collaborative software to public agencies and corporations for use in emergency response management, facility and event security, disaster preparedness and recovery, and business continuity.

## CONCLUSION...

The ultimate goal of any evacuation planning effort is to maximally reduce the number of casualties in case of possible hazards. Being capable of promptly initiating an evacuation, ensuring that occupants take appropriate actions during the evacuation, and being able to account for people after an evacuation may make the difference between life and death. The concept used by Evacuation Planning approach is to analyze possible hazard scenarios for the given facility (building, town, etc.) and develop procedures for safe transfer of people from the affected area into safe areas.

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