THE IMPACT OF AUTOMATION ON THE CHEMICAL STOCKPILE DISPOSAL PROGRAM

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ABSTRACT

Current plans for the disposal of the nation's stockpile of chemical weapons has brought advanced simulation and modeling systems to organizations, a number of which heretofore have had little or no access to automation. The information required by and provided by these technologies has had a dramatic impact on both the personnel involved as well as traditional planning philosophies. This paper discusses this impact and offers insights for simulation application developers on the impact of their work.

1. HISTORICAL BACKGROUND

In compliance with agreements signed by several nations at the Chemical Weapons Convention in January of 1993, the United States is mandated to destroy its current stockpile of chemical agent munitions before the year 2000, with the possibility of a one-time, five-year extension until 2005.* In all, this amounts to some 25,000 tons of chemical agents. Some of these agents are stored in explosive ordinance, some in bulk storage containers

The locations of these stockpiles were chosen for various reasons, not the least of which was their relative remoteness from civilian populations or other large strategic targets as defined in the Cold War years. For several of the stockpile sites, this remains true today. However, protection of the civilian population around these sites is still imperative, which led to the creation of the Chemical Stockpile Emergency Preparedness Program (CSEPP) under the auspices of the US Army and the Federal Emergency Management Agency (FEMA).

The method proposed by the US Army for the disposal of these munitions is through incineration. This activity is currently being conducted on Johnston Atoll in the South Pacific. However, after a risk assessment was conducted, it was decided that on-site disposal of the chemical agent stockpile in the continental United States was safer overall than transport to a single demilitarization facility. Currently, the US Army plans to construct incinerators at eight stockpile sites in the United States.

2. SIMULATIONS FOR CSEPP

To assist emergency personnel plan for emergency response, the US Army has

* National Research Council, Alternative Technologies for the Destruction of Chemical Agents and Munitions, National Academy Press, 1993, 1.

provided them with some relatively advanced modeling and simulation technologies, along with support for training in the proper use of these technologies. My company, Innovative Emergency Management, Inc., has been tasked to provide this training support.

Two distinct automated systems have been developed under US Army directives for use by military and civilian CSEPP personnel. The first, IBS (Integrated Baseline System), was developed by Pacific Northwest Laboratories (Richland, Washington). It is designed to support CSEPP planning and response for civilian personnel. The second, EMIS (Emergency Management Information System) was designed by Applied Computing Systems (Los Alamos, New Mexico) to support CSEPP planning and response for the Army.

Hazard Simulation: D2PC

Both systems employ the same simulation application for modeling a real or hypothetical release of a chemical agent. This model is known as D2 for the second iteration of a dosage modeling system developed by the Army for battlefield simulations. It has been ported to the PC and now goes by the acronym D2PC.

Evacuation Simulation: IDYNEV

In addition to the D2PC model, the civilian automated system (IBS) includes an evacuation simulation called IDYNEV. This model uses current US Census Bureau data to simulate the migration of populations along evacuation routes created or modified by the end-user. In IBS, the user may choose to synchronize the D2PC simulation with the IDYNEV simulation to obtain a comprehensive view of both human behavior and the potential impact of an accidental release of chemical agent on the human population.

Details of the Simulations

The D2PC model requires various types of input from the user, primarily information about the nature of the chemical agent release and current or hypothetical meteorological conditions that will affect how the agent is dispersed in the atmosphere. The user must know, for example, the type of chemical agent released (since physical properties bear upon the behavior of the agent in air), the nature of the event (explosive, spill, etc.), the amount of agent involved, and the type of munitions. Each of these inputs may require additional data.

The meteorological data required may be real-time (for sites which have meteorological recording stations) or hypothetical. Obvious required data include wind direction and speed, temperature, and the Pasquill stability class which may be calculated by the model based upon certain defaults for the site in question. Other meteorological data, such as the height of the mixing layer, and the Frost slope profile, may be entered by the user or taken as default for a particular site and season.

Together, the event data and the meteorological data are processed by the D2PC simulation to generate both textual and graphical output. In the case of graphical data, these are converted into a depiction of the dispersion of the agent over space. This depiction includes "dosage contours" established by the model and actual transit time data generated by another function PARDOS (PARtial DOSage) which shows where the agent cloud will be at what time.

A sample screen showing a hypothetical release of nerve agent is shown in Figure 1.

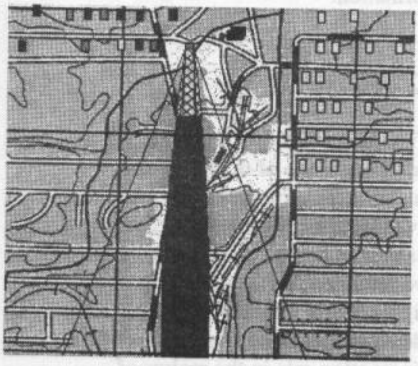

Figure 1: Hypothetical release of chemical agent as depicted by D2PC model and PARDOS

The IDYNEV simulation requires similar data from the user. First, users must develop an evacuation network for each area at risk from a potential chemical agent event. This requires them to create "centroids" which indicate where the population will enter the network, "links" which describe road characteristics such as the number of lanes, where turns may be made, and so forth, and "nodes" which represent intersections or changes in road type. Furthermore, additional data regarding people and their behavior is required. These data include population type (daytime/nighttime), and persons per vehicle, and the loading rate for the evacuation model.

The IDYNEV simulation steps the model through time at increments which may be set by the user. At each step, the user may query a point, node, or link, to determine such things as the current average speed on a link, the number of people who have passed through a node, the percentage of the total area population that has exited the network, and so forth. A sample of the IDYNEV output is shown in Figure 2.

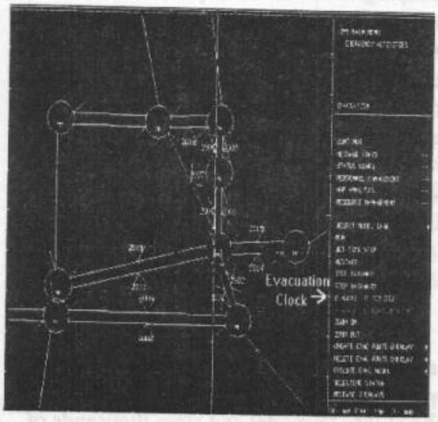

Figure 2: Output from the IDYNEV evacuation model

3. IMPACT

The impact of this technology on the organizations that are now using it is enormous. For many of the communities that IEM is involved with in training, this represents quite literally the first automation they have used outside of a word processor. It is, in the best of cases, the first automation they have used that provides simulation technologies.

Access to these technologies carries with it what I, as a trainer, would call a "paradigm shift" in the minds of the planners and responders I have trained and talked with. Wholly new methods of data gathering, new insights into what the simulation technologies provide, and new guidelines for coordinating this information across various jurisdictions must be considered. Simply put, these simulation technologies promise a wealth of information and guidance must now be considered on how this information should or must be handled. Personnel who may have had no greater responsibility than notifying the local fire department of a hazardous material spill are now expected to provide decision-makers with detailed and accurate information on the behavior of a complex chemical compound under various meteorological conditions. Planners who were weaned on the philosophies of the Cold War era face similar challenges from simulation technology. What happens to plans forged with pen and paper in the face of simulation technologies?

Accommodating these new technologies has also resulted in a phenomenal demand upon personnel at most of the CSEPP sites. The ability to model and store thousands of simulated agent releases and tens of evacuation simulations requires considerable dedication and time on the part of CSEPP personnel.

Political Issues

The types of data required by the D2PC and IDYNEV models also broaches the issue of protocol and policy regarding he exchange of information between military and civilian agencies. For example, the D2PC model requires information regarding the nature of a chemical event that military coordinators simply may not know in the short time-frames required to use the model in the first minutes after an event.

Interpreting the output for the simulation is another issue. The D2PC model is capable of generating contours which indicate various statistical probabilities regarding the effects of exposure to a chemical agent. This is usually displayed as the "No Effects," "No Deaths," and "1% Lethality" contours. Currently policy requires that planners use the lowest of "No Effects" contour. This poses a new dilemma for planners and responders in regard to how best to use this information.

4. CONCLUSION

The point of this brief paper has been to touch upon some of the issues that simulation technologies raise when they are moved from the laboratory to the real world. It cannot be denied that such technologies have provided and will continue to provide insights across virtually all scientific endeavors. Certainly simulations will play an increasing role in the realms of environmental research and hazardous materials handling.

In short, the effect of simulation technologies has been overwhelming in some instances in the CSEPP program. Where before there seemed clear-cut answers to the dilemmas of planning for emergencies, simulation technologies in fact blur these assumptions and force emergency planners to face the question: now that we can model acceptable impact, what impact are we willing to accept?