SIMULATING THE BIG ONE:
USE OF SIMULATION FOR DISASTER TRAINING

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ABSTRACT

As part of a recent technology transfer initiative on the part of the U.S. Armed Forces, constructive simulation models are being modified to train civilian leaders in the area of emergency management and disaster relief. This paper will propose a methodology for ensuring that training effectiveness will be maximized throughout the development cycle, as simulations are converted from military to civilian application. An outline for the design of a simulation exercise is included that can be used to design and conduct effective training exercises using constructive simulation. The design methodology calls for the sharing of technology resources across various community segments, including schools, health and emergency aid agencies, and government organizations.

ABOUT THE AUTHORS

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During the latter part of the nineteen-eighties, the U.S. Army underwent a major change in its approach to the training and preparation of senior commanding officers and their staffs for participation in future conflicts. This resulted in the development of a number of computer-based simulations, and incorporation of the simulations into training programs for these officers and staffs.

On the basis of the proven success of the U.S. Armed Forces in developing effective staffs during Desert Shield / Desert Storm, the possibility of modifying these simulations to train managers in non-military industries and services was considered. As simulations are being modified for use in civilian disaster management applications, the lessons learned by the military must be incorporated at the earliest stages of design to ensure that the maximum level of training effectiveness remains intact.

A computer-based simulation supports and drives specific portions of a training exercise in order to enhance the delivery of information to the training audience. The trainee learns from the simulation exercise by actually performing the activities in a context that is similar to the actual event, with similar equipment and procedures (Alessi & Trollip, 1991). A well-developed training strategy should be an integral part of the simulation development process, from conceptualization through the maturity of a fielded simulation. Developing software to drive an exercise without clearly defining the training audience and learning objectives will most often lead to unfulfilled training expectations. Negative reactions can cause setbacks to a potentially worthwhile training program, or in some cases, cancellation. This paper will propose a methodology for ensuring that training effectiveness will be maximized throughout the development cycle as simulations are converted from military to civilian application.

BACKGROUND

The U. S. Armed Forces are the world's forerunners in the development of simulations for all aspects of training. A large percentage of simulation-based exercises were designed to train multi-faceted functions through the use of what are referred to as constructive simulations. Constructive simulations, or wargames, involve software representation of two or more opposing forces, using rules, data, and procedures that are designed to depict an actual event or real-life situation (Tucker, 1993). Prior to the implementation of a constructive simulation exercise, an in-depth needs analysis is conducted, and the key indicators of the success of the participating officers and their staffs are identified.

Since the Cold War ended, the concept of modifying military simulations for use in civilian applications has come into focus. This concept was reinforced over a two year period during which the U.S. experienced a number of natural disasters (i.e., Hurricane Andrew, floods in the mid-west, earthquakes on the west coast, and multiple forest fires). In each instance, local organizations were not thoroughly prepared to handle the magnitude of those situations. Exercises designed to train emergency management teams failed to prepare them for the reality of the actual disasters they had to face. A more effective emergency management training program is needed that will incorporate communication between the various agencies, resources, and government officials that would be called upon to respond to a disaster.

The U.S. Armed Forces have developed simulations that train staffs to work as integrated teams under realistic wartime conditions. To transfer this method of training to a civilian application, a simulation is modified to represent a local community undergoing a natural disaster. A proof of principle is currently being developed to focus on management, direction, and control of limited emergency resources. This effort is a joint venture involving the U.S. Army Simulation, Training and Instrumentation Command / Project Manager for the Family of Simulations (STRICOM/ PM FAMSIM), the University of Central Florida-Institute for

Simulation and Training (UCF-IST), United States Military Academy (USMA), U.S. National Guard, Florida National Guard, the State of Florida Army Reserves, and other organizations including the Federal Emergency Management Agency (FEMA).

As part of this project, modifications to the U.S. Army's Janus simulation model have been initiated that will accommodate civilian applications for the training of disaster relief personnel. Enhancements to the Janus database will support emergency management events, functions, and scenarios (Petty & Slepow, 1995). While this modification is essential, this paper will not focus on the enhancements to the database, but rather on inserting training design methodology into the entire redevelopment process. Database development will only be mentioned where there is a correlation between the methodology and a desired outcome in terms of simulation exercise requirements.

This remainder of this paper will discuss the application of simulation-based technologies to emergency management training. A five-phase approach to designing simulation exercises is provided, along with an example based on a county-wide disaster preparedness training exercise.

EXERCISE PARTICIPANTS

Customer

The customers for the emergency management simulation exercise would include county-level managers responsible for overseeing emergency management personnel, emergency support agencies, and representatives from field operations such as local fire stations, hospitals, public utilities, and sheriff's offices.

Facilitator

The facilitator will be responsible for identifying the target training audience, and will centralize the overall scope of the exercise. The facilitator will gather information on the organizational structure of the specified county's emergency management personnel and oversee the design of the training exercise.

TRAINING METHODOLOGY

During the preparation for and conduct of the simulation exercise, a five-phase approach will be utilized which involves a pre-exercise phase, initial research phase, design phase, exercise phase, and feedback phase (see Figure 1).

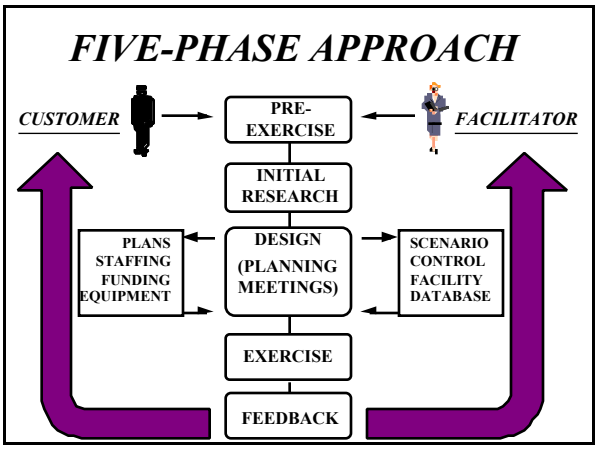

Figure 1. The five-phase approach to developing a simulation exercise.

Pre-Exercise Phase

The pre-exercise phase is initiated once the county manager has identified the need for exercising the emergency management personnel within the county. Copies of the organizational structure and operating procedures for each participating agency are provided to the training facilitator. Based on the training objectives specified by the county manager, an exercise plan is developed. Design emphasis is placed on the ability to create a stressful environment for each trainee within the target audience. The instructional goal is to significantly improve the decision-making skills of the participants by having them practice their responses to stressful situations created by the simulation exercise.

Initial Research Phase

After the facilitator has identified the target audience (e.g., local community emergency management agencies) and has established that the training will be based on conducting a computer-based simulation exercise, research must then be conducted in the following areas:

- identifying the organizational structure of the emergency management cell;
- identifying the organizational structure of the field operations (e.g., fire and rescue services, local hospitals, and the sheriff's office) and their standard operating procedures;
- securing diagrams of the facilities to be included in the communication layout;
- identifying standard procedures for communicating with county, state, and federal agencies;
- identifying assets and resources available within the management area; and

- identifying the area of jurisdiction for each of the emergency management agencies.

This information will then be used to design the simulation exercise. To accomplish this, a concept paper describing the layout of the training simulation is developed. The paper is then presented for review by the facilitator during the initial planning meeting.

Design Phase

A functional matrix of the critical responses and tasks that may be required during a state of emergency should be laid out. This matrix serves as a point of reference for designing the simulation exercise. In addition to compiling the matrix, three meetings are conducted during the design phase in which effective training objectives are developed and a suitable instructional strategy is planned.

Initial Planning Meeting. During the initial planning meeting, a clear and concise definition of the target training audience is established. Training objectives are developed, based upon input from training facilitators, subject matter experts, and representatives from the target training audience. An outline for the conduct of the exercise is planned based on the capabilities and limitations of the computer model. These elements are key to a successful training program.

An agenda of development objectives for the initial planning meeting is provided to all participants at least a week in advance, with time allotted for proposing revisions (see Figure 2). A training facilitator should lead the initial planning meeting to ensure the agenda is covered, guidelines are observed, and that an effective exercise concept is developed.

The training facilitator is responsible for ensuring that each member of the development team participates in the brainstorming session in the initial planning meeting, while maintaining the focus of the agenda. The facilitator also ensures that each part of the agenda results in a product that will serve to support the exercise design. Opening remarks by the county manager provide the overall purpose and direction for the simulation exercise.

Initial Planning Meeting
May 17, 199 _
Disaster Preparedness Drill
Drill Date: July 10 - 14, 199_

TIME	TOPIC
0800-0810	Introduction
0810-0820	Opening Remarks
0820-0900	Drill Objectives
0900-1000	Proposed Drill
1000-1100	Technical Aspects
1100-1200	Finalize Concept

Figure 2. Sample agenda for initial planning meeting.

Options proposed at the initial planning meeting will aid in developing an accurate definition of the target training audience and centralizing the overall scope of the exercise. Once the target audience and scope of the exercise are adequately defined, the subject matter experts provide a capability review for simulation, communication, and facility support. A detailed review of all three technical areas is planned for a later time in the process, and will result in detailed specifications for each area.

By reviewing the organizational structure, each agency can verify the structure and responsibilities within the emergency management cell to ensure the exercise plan is both realistic and feasible. The objectives set forth by individual agencies are reviewed during this phase, and those that do not contradict the overall training objectives are incorporated into the exercise.

Finally, a fully developed concept is reviewed, and assigned responsibilities for deliverables are reiterated. Upon completion of the initial planning meeting, a copy of all minutes is published and distributed to all participants.

Interim Planning Meeting. The design emphasis during the interim planning meeting focuses on ensuring that the exercise will allow the emergency field organizations (e.g., fire, police, and medical) and the private industries existing within the county to rehearse the communications that are necessary prior to, during, and after an actual emergency situation occurs. Providing for accurate communication within and among the different participant agencies is a critical part of the design phase.

Building upon the objectives established during the initial planning meeting, the facilitator

designs a system to track important aspects of the exercise. Prominent design issues at this stage are the exercise structure and locus of control. All elements of the response to an emergency situation must be represented to ensure that a sense of realism is provided for the target audience in the simulated environment. Replication of those functions and organizations not participating within the exercise must be well designed to ensure transparency. The interim planning meeting results in establishing four elements of the exercise: a lead-in scenario; exercise locus of control; technical communication procedures; and facility layouts.

The lead-in scenario will establish the starting position for each of the emergency resource teams, and ensures that all participants initiate the exercise with the same perspective. This information must be shared with the simulation technologist who builds the database so that the simulation is in accordance with the scenario information.

For certain simulated disasters (e.g., an impending hurricane, fire, or flood) lead time must be provided prior to the simulation event in the form of a starting position for the disaster that is outside of the participating county. In other exercises, county managers might desire a spontaneous event such as an earthquake or tornado. Once again, the characteristics of the simulated disaster would depend upon the training objectives established during the initial meeting.

Activities leading up to the initialization of the simulation must be scripted. The scenario and starting positions must be sent to all participants for review prior to the final coordination meeting. Feedback on changes should go through the facilitator to ensure that the revision is acted upon by responsible individuals.

Based on the scenario, the exercise control plan is developed. One lesson learned by the U.S. Armed Forces when using computer simulations is that the agencies participating in the exercise cannot operate as both the simulation controller and the training audience. This is not limited to staff-level participants, but includes all individuals within the decision-making process including those in leadership positions. By including a control cell as a buffer in the design of a simulation exercise, then regardless of the exercise elements the simulation presents, the training audience will be reacting to the situation within the scenario instead of "gaming" the computer.

If the emergency management cell is activated with the county manager in charge, then that individual would participate as part of the target audience and would not have control over the scenario elements nor access to data exclusive to the control of the simulation. This ensures the decision-making processes of participants occur as a result of scenario information presented by the simulation, and not due to anticipation of simulation control cues. Control should consist of all those feeds that are needed to force the cell to operate all functions. This includes, but is not limited to, interaction with federal and state agencies, adjacent counties, private industry (e.g., gas companies, electric companies, etc.), and units in the field. Not only does the control cell provide input for the scenario, but it also deals with requests made by the participants. For instance, requests for assistance or information would be reviewed by the controllers and responded to in a realistic manner and time frame according to the scenario and training objectives.

Once the size of the training audience and the control staff are identified, the technician and the facilitator can conduct site surveys of the facilities that will be used during the exercise. Whenever possible, facilities and equipment that are used during an actual disaster should also be used during the exercise. Additional equipment from the computer simulation and equipment for a control cell should be accounted for in the power and facility layouts. Communication technicians should be a part of site surveys, so that all communication links available in the real world system are replicated in some manner. Attention should be paid to real-world equipment being fed computer generated signals and the feasibility to support those requirements. A location should also be identified for the purpose of conducting after-action reviews (AARs). Diagrams that include furniture, equipment, and communication conductivity should be available for all facilities. Once facilities are agreed upon, a timeline is developed that will allow for equipment installation and system tests prior to the start of the exercise.

During this period of time, contact is made with subject matter experts who will be available to participate in the exercise. These individuals (e.g., FEMA representatives, disaster medical care managers, news personnel, etc.) should represent a variety of fields and are needed to provide expertise on specific topic areas. Prior to the simulation exercise, input from these individuals can ensure that realistic situations are developed to meet the training objectives. Participation by subject matter experts in the design phase contributes to the fidelity and credence of the simulation exercise.

Final Planning Meeting. The same participants who attended the initial planning meeting

should be present at the final planning meeting to ensure continuity. The purpose of this meeting is to lay out the exercise for all individuals from top to bottom. All aspects of the training event should be reviewed, and any unresolved issues from the previous meeting should be resolved (see Figure 3 for a sample agenda). To facilitate completion of the design phase, copies of the briefing slides should be made available for review by all principal participants involved with the exercise.

Final Planning Meeting
June 17, 199 _
Disaster Preparedness Drill
Drill Date July 10 - 14, 199_

TIME	TOPIC
0800-0810	Introduction
0810-0820	Opening Remarks
0820-0900	Sub-drill Objectives
0900-1000	Scenario / Control
1000-1030	Technical Aspects
1030-1100	Approve Concept
1100-1200	Facilitator Briefing

Figure 3. Sample agenda for final planning meeting.

Once approved, the database goes to final review and the system is checked to ensure that no software or hardware problems exist. Finally, the central training facility is set up, and all systems are checked and verified to be operational prior to commencement of the training event.

Exercise Phase

For a four day training exercise, a county manager may make a decision to start on a Friday afternoon with a simulated disaster due to strike within twenty-four hours. The benefit of this training situation is that the emergency response cell can be activated after offices are closed on Friday, and will not interfere with regular business hours.

Prior to the start of the simulation exercise, there is a need for preliminary training for both the controllers and the training audience. Controllers need to be aware of the overall scenario and the specific positions or roles they will play. Also, if the controller is interacting with the computer simulation, he or she will require a certain amount of training on use of the equipment. As a group, the training audience will need a briefing on the objectives, scenario, and exercise architecture. A short period of time should be allotted for the training audience to conduct positional training and communication checks. The simulation exercise should not be implemented until these elements are in place.

The following section describes a simulation exercise based on a hypothetical county's response to a simulated hurricane. This is only one example, as an actual exercise would be designed for a specific training audience based on a determined set of instructional objectives.

Example Exercise. On a Friday, a simulated state of emergency is declared in response to an approaching hurricane. The county manager activates the emergency center and, based upon information from the National Weather Center and state agencies (control functions), begins preparing the county for the anticipated state of emergency. The first segment of the simulation exercise involves the preparation of the participating agencies, individuals within the scenario (residents of the county), resources, and structures for the impending emergency.

Decisions that are made are logged into the simulation computer, and the simulated responses are enacted. For example, if the decision to evacuate an area is made and logged into the system, then simulated entities representing individuals and vehicles would be moved to designated shelters within the scenario or to locations outside the county. These responses would be effected by factors such as heavy traffic, accidents, or road blocks limiting travel, and occupancy limits at shelters.

To monitor data related to the actions of a vehicle within the scenario such as a police car, the simulated vehicle must be located within the scenario where it can make 'observations,' or a command must be made to send the vehicle to that location to obtain information.

As the hurricane approaches, the situation begins to deteriorate and the county manager may receive reports of injuries, minor property damage, and flooding. The preparation segment continues until the leading edge of the hurricane is an hour away from entering the county. As this segment ends, the elapsed time would be noted so that an after-action review can be conducted on activities related to this segment.

The second segment of the training exercise continues as the hurricane enters the county, and lasts until approximately 12 hours after the hurricane has passed. During this segment, information to the emergency response cell would slow, or possibly cease until the simulated hurricane has passed over the operational areas.

Meanwhile, the most severe damage has occurred throughout the county, and a course of

action is needed for execution once the storm has passed. After the hurricane has passed through the county, information on the condition of residents and property, and the status of emergency agencies begins to flow in. The county manager's plan of action must be adjusted to deal with the incoming events.

The third segment involves restoration of essential services, additional gathering of information on the status of individuals and property, and assessment of how well emergency agencies are dealing with the situations at hand. The county manager and participating agencies continue to analyze the situation, and decisions are made to provide support as the need arises. As each segment of the exercise ends, the elapsed time is again noted for reference during the after-action review.

Throughout the simulation exercise, additional emergency response scenarios are inserted (i.e., looting, secondary fires, water shortage, etc.) to enhance the exercise. The control cell must ensure that the tempo of the exercise maintains an adequate state of stress for the participants without totally overwhelming them. Otherwise, the effectiveness of the training is jeopardized.

Other distractors must also be programmed into the exercise to ensure that the situation is realistic to the participants. Involvement with local press in mock interviews, TV-fed weather updates, and unforeseen emergencies (e.g., damage to a shelter) should be inserted so that all critical functions that the county manager and his staff must be prepared to perform are exercised.

Feedback Phase

To ensure that the exercise participants have the ability to review their performances, an after-action review (AAR) is conducted for each segment of the simulation exercise. The purpose of the AAR is to allow the county manager and other participants to examine the decisions that were made during the simulation, and to discuss the effectiveness of actions taken.

10 minutes	Review the events, decisions, and responses that took place during the training segment. This might include re-playing the log tape of the simulation segment, recapping the major decisions made during the course of the segment, and reviewing a timeline of key responses by the emergency action cell
10 minutes	The county manger and key participants provide a brief commentary on the exercise from their points of view.
60 minutes	Based on observations and an analysis of the computer simulation, the facilitator will identify key issues for the participants to discuss. These issues should be cleared with the county manager before the AAR begins.
10 minutes	The county manager and each key participant will brief the remaining participants on the key issues discussed, and any suggestions for improvement or revised actions will be discussed at this time.

Figure 4. Example of an after-action review (AAR) agenda.

The training facilitator who leads the AAR encourages participants to discuss issues and possible solutions. Also, it is helpful to have subject matter experts on hand for the AARs, so that they may offer advice in their respective areas. For instance if the county manager struggled with a mock TV interview, a representative from the local news station might present some insight on interview techniques during the AAR. A sample agenda for an AAR is presented in Figure 4.

The process of following each exercise segment with an AAR allows each participant in the simulation exercise an opportunity to discuss his or her perspective, and to work toward an understanding of the functions and responsibilities of other participating agencies and emergency response personnel.

At the end of simulation exercise, there should be a wrap-up session for all participants to discuss lessons learned, and to develop plans for modifications to current procedures or policies where necessary. The facilitator should request that each participant and controller in the training audience provide a written evaluation of the simulation exercise. This information should be compiled into an after-action document along with an outline of the

exercise design and any lessons learned during the implementation of the simulation.

CONCLUSION

Taking a proven training tool from the military and modifying it for civilian use is a logical and positive initiative. To design a model for natural disaster so that an emergency action staff can simulate responding prior to being faced with an actual event has the potential to save lives, resources and property. The key to the success of a simulation exercise, whether for emergency management or some other training need, is ensuring that the training design methodology maximizes the effectiveness of the learning experience.

Further study is needed in this area to determine the key issues facing county managers and their staffs when dealing with emergencies brought on by natural disasters, and the effectiveness of using simulation exercises for training.

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