A TASK-BASED APPROACH TO TRAINING, EVALUATING, AND SIMULATING WMD RESPONSE BEHAVIORS

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ABSTRACT

The Automated Exercise and Assessment System (AEAS) is a simulation sponsored by the National Guard Bureau to enhance coordination in the civilian world of emergency response to Weapons of Mass Destruction (WMD). The system simulates WMD events to allow emergency responders to utilize their own Incident Command System and generally exercise cognitive and decision-making skills to respond to the crisis. The WMD scenarios will cover a range of incidents, including chemical, biological and radiological attacks.

Simulating such wide ranging and complex events can quickly become intractable. Each command decision made in a scenario has downstream consequences. The traditional computer-based training approach would be to use a decision tree, but the complexity of the scenarios makes enumerating all possible paths unreasonable, limiting the allowable decisions. Instead, AEAS has formalized Tasks, Conditions and Standards (TCSs) for each emergency response role in a given type of WMD situation. These TCSs are encoded in a command-based format and used to track and drive decisions in the simulation. This formalization allows players to be evaluated against a set of expected actions as well as prompted for correct actions in a training format. The TCSs are also used to guide simulated entities which may be standing in for human role players, permitting a simulation run to be adaptable to the available training audience size. The expected actions in a situation comprises one of a set of evaluation conditions that also includes overall simulation results such as fatality and property damage mitigation, and public opinion. This paper will discuss how a set of TCSs can be derived, used to drive player and simulation actions in a given scenario, and how they are incorporated into the After Action Review and evaluation criteria.

ABOUT THE AUTHORS

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INTRODUCTION

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Simulating such wide ranging and complex events can quickly become intractable. Each command decision made in a scenario has downstream consequences. The traditional computer-based training approach would be to use a decision tree, but the complexity of the scenarios makes enumerating all possible paths unreasonable, limiting the allowable decisions. Instead, AEAS has formalized Tasks, Conditions and Standards (TCSs) for each emergency response role in a given type of WMD situation. These TCSs are encoded in a command-based format and used to track and drive decisions in the simulation. This formalization allows players to be evaluated against a set of expected actions as well as prompted for correct actions in a training format. The TCSs are also used to guide simulated entities which may be standing in for human role players, permitting a simulation run to be adaptable to the available training audience size. The expected actions in a situation comprises one of a set of evaluation conditions that also includes overall simulation results such as fatality and property damage mitigation, and public opinion. This paper will discuss how a set of TCSs can be derived, used to drive player and simulation actions in a given scenario, and how they are incorporated into the After Action Review and evaluation criteria.

Figure 1. Functional Areas and the number of Tasks assigned to each. Unless noted, tasks are executed in the EOC.

THE AEAS CONCEPT

The primary purpose of the Automated Exercise and Assessment System is to evaluate a community's ability to respond to a WMD event. The training audience consists of command-level personnel on the scene and in the EOC (Emergency Operations Center), rather than the personnel on the ground performing physical tasks. AEAS allows decision-makers to command their simulated resources and to coordinate with other decision-makers, and to see the consequences of those decisions.

For a given emergency situation, the tasks that must be performed are broken down by *Functional Areas (FAs)*. The origin of Functional Areas is the Emergency Support Functions used for delineating responsibility in emergency management. AEAS has defined 36 Functional Areas, ranging from Law Enforcement to Debris Management (see Figure 1). Some Functional Areas work primarily

on the scene, whereas some work primarily in the EOC. The FAs are organized into a command hierarchy based on a jurisdiction's particular implementation of the Incident Command System (see Figure 2). The hierarchy can change over the course of the scenario, as players assume and delegate Functional Areas.

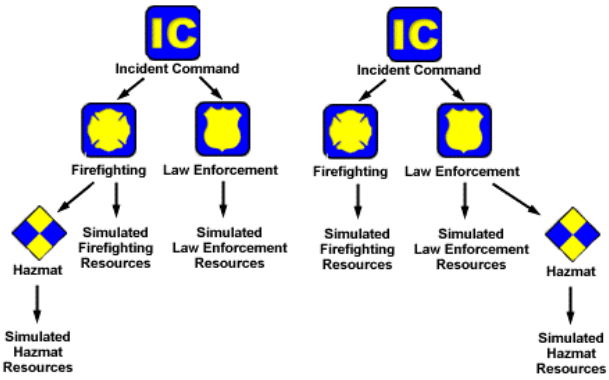

Figure 2. Two sample command hierarchies.

The AEAS product consists of four components: Survey, Player Station, Controller Station, and After Action Review (AAR). In the Survey, the closest geotypical match for the players' jurisdiction can be found. Four geotypical areas are available, ranging from a small rural settlement to a large city. The user then defines the jurisdiction's emergency response resources (such as Fire Trucks), including their capabilities, number, and geographical distribution. Any resources available through Mutual Aid agreements are also enumerated. These resources are then imported into the exercise so that the players can deal with the exercise scenario using their own jurisdiction's capabilities.

The *Controller* is the facilitator for the exercise, setting up the exercise parameters such as selecting the scenario to be played and monitoring the progress of the exercise. The controller can tailor the resources specified so that geotypical or specialized resources can be used, allowing AEAS to be used as a planning tool. The controller also assigns FAs to each player and sets up communications networks to reflect those of the jurisdiction.

Each player has a Personal Computer networked to the other player stations and the simulation. The players can give commands to the resources they control, build the command hierarchy, and communicate with each other and with simulated support functions (see Figure 3).

The AAR provides fodder for discussing the results of the exercise, because not all questions have "right" answers.

FORMULATING TASKS, CONDITIONS, AND STANDARDS

The overall goal of AEAS is to assess a community's readiness for WMD events. In order to accomplish this goal, a set of Tasks, Conditions, and Standards (TCSs) to assess against was needed. In the military world, Standard Operating Procedures (SOPs) define what actions should be taken in a given situation but they are very detailed, usually a step below the overarching decision making process. Civilian responder agency SOPs vary greatly from jurisdiction to jurisdiction. AEAS requirements stipulated that a jurisdiction be able to use its own procedures and equipment to respond to the simulated WMD event, so a particular method of accomplishing a high-level task could not be used as an assessment standard. The assessment must instead be done at the decision making level.

To accomplish this, a set of TCSs was formulated for each scenario type. Each TCS set was organized by Functional Area. The Condition, which is a set of circumstances under which a task is performed, was defined by the scenario type. An example of a condition might be "When acting as the Incident Commander in an emergency situation involving a hazardous material." Standards, baseline measurements or rules governing how a task should be done, were taken from authoritative data. A set of high level command and control Tasks were identified and reviewed by subject matter experts in each Functional Area, and approved by the AEAS

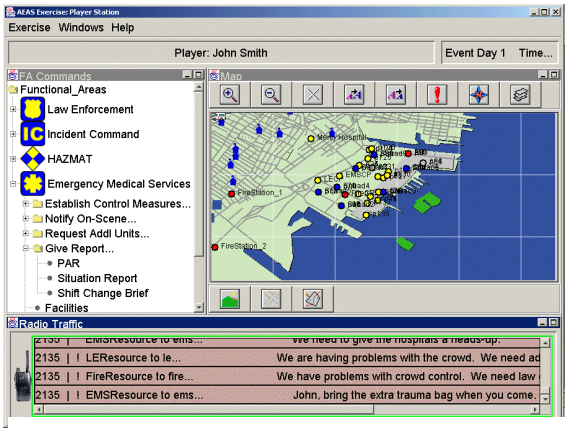

Figure 3. AEAS Player Station

Review Board members and Stakeholders. Each task has one or more references citing authoritative data, such as FEMA or National Fire Protection Association publications. The Tasks were deliberately kept general, focusing on the organization and command elements of the situation.

The TCSs by themselves provide a useful Field Operations Guide (FOG) for Emergency Responders. The FOG is available as a help function from the AEAS interface.

CREATING A SCENARIO

A scenario database provides stimulation and context to the simulation. It contains background information to set up the scenario for the players, specifies positioning of any predeployed resources, and specifies the types and severity of injuries caused by the WMD agent. It also contains scripted events that happen at predetermined points in the time line, such as a sarin release. The scripted events provide basic impetus for the simulated resources. The simulated resources do their jobs as commanded by their supervisors (the human players), further driving the simulation.

Task: Approach Scene
Condition: While serving as Fire Group Commander within ICS in the management of crisis and consequences of an act of terrorism involving a HAZMAT.
Standard: Fire Group approaches scene from an upwind direction via a safe (uncontaminated and secured) route, establishes water supply, hose lines and suppression duties, avoids contact with unknown liquids, and isolates hazard area.
References: NFPA 471, NFPA 472, Chaps 2,4,5, FEMA Region VI HAZMAT Exercise Evaluation Supplement, p. 8, NFPA Supplement 14, Emergency Response to Incidents Involving Chemical and Biological Warfare Agents, SBCCOM Guidelines for Responding to a Chemical Weapons Incident, Annex A
Expected Actions
Establish an Entry Corridor
AND
Establish an Exit Corridor
AND
Establish a Hot Zone perimeter

Figure 4. Example of a Task, with its associated Condition, Standard, References, and Expected Actions

The TCSs proved generalized Tasks that should be accomplished for each type of scenario. The next step is to make a set of Tasks (i.e. Chemical TCS) specific to a scenario (i.e. a sarin release at an outdoor concert), and define what actions the player has to take to accomplish a Task for that scenario. This set of information is contained in an *Expected Action*. Each high-level Task has one or more Expected Actions (see Figure 4). For assessment purposes, we are grading fulfillment of these actions. Expected Actions can be *fulfilled* by the player performing one command, multiple commands, or one command from a set of several viable options.

For example, the Firefighting Task "Approach Scene" would have three Expected Actions: "Establish the Entry Corridor", "Establish the Exit Corridor", and "Establish a Hot Zone". Each action listens for one or more player commands that will satisfy it. In this case, defining the entry and exit corridors and hot zone are commands available from the player's "Establish Control Measures" menu. If the control measures are not defined within a certain simulation time, the player will be reminded. The reminder comes as it would in a real world situation, such as in a radio message from a subordinate saying "Advise we set up entry and exit corridors and a hot zone." The player must pay attention to the radio traffic to pick up on the reminders.

The complete set of Tasks for a scenario are omniscient: we know what events are going to happen. At any given moment, however, some of the tasks are not yet applicable. Therefore, Expected Actions may be active when the simulation begins, or, more often, they may be *triggered* by some event in the simulation. For example, an Expected Action where the player is required to identify the type of hazardous material involved may be triggered by the event of a simulated entity on the scene reporting his symptoms. In this example, the trigger is a scripted situation report given by a simulated entity in the area of the hazmat release. Two minutes after the sarin release, the simulated entity sends a radio message indicating multiple casualties in the area and describing his watery eyes and difficulty breathing. This triggers the Expected Action of identifying an organophosphate chemical release. The player must indicate he realizes an organophosphate is involved either by making a report to his superior or by requesting a plume

model. If he fails to identify the type of hazmat, it will be reflected in his assessment.

Triggers do not have to be pre-scripted events. This gives the assessment a lot of flexibility to respond to the decisions that were made previously. For example, a Task may state that the scene should be periodically reassessed for safety. The player may initially have positioned his staging area downwind of the hazmat release. When the plume expands and contaminates the staging area, the simulation will generate a triggering event indicating that a control measure is under the plume. This will activate an Expected Action requiring the player to relocate his staging area to a safe place. Similarly, Expected Actions may be triggered by requests for assistance from other players, the arrival of specialized equipment, supply consumption, or any other simulation events.

ASSESSMENT AND TRAINING

Given a set of Expected Actions on whose completion the player will be assessed, a method for assessment must be defined.

Assessment Methodology

Four levels of assessment are defined for the Expected Actions: Green, Yellow, Red, and Not Applicable. Green indicates the player fulfilled the Expected Action within the appropriate time. Yellow indicates the player was prompted and then fulfilled the Expected Action. Red indicates that the player did not complete the Expected Action, or completed it too late to prevent adverse consequences. The fourth level, Not Applicable, indicates that the Expected Action was not triggered during the scenario run.

When the Expected Action becomes active, the player has a specific amount of time (which varies by action) to give the command(s) which will satisfy it. If the player gives the commands during the specified time, his assessment for that Expected Action is Green. If the player does not give the commands during the specified time, a reminder will be given, as discussed in the previous section. The highest assessment he can now get for the Expected Action is Yellow, indicating that he was prompted. If he still does not give the commands during a further specified amount of time, or if a specified event happens (such as extra injuries resulting from the commands not being given) his assessment for that Expected Action will be Red.

To facilitate the AAR, if the Red assessment results from a specific event, a note will be displayed in the Assessment Summary indicating what happened. For example, if several responders arrive on the scene before the staging area is specified, their arrival will trigger a Red assessment and the Assessment Summary will display the note “Responders arrived on the scene before the staging area was established, causing traffic congestion and reducing response time to the scene.” (See Figure 5)

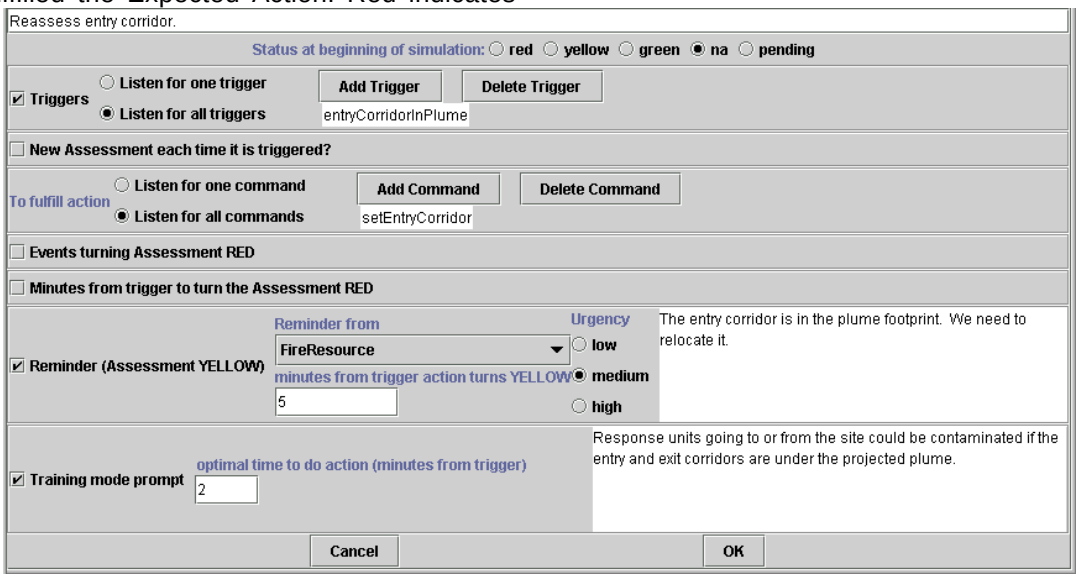

Figure 5. The Expected Action editor, showing the description, triggers, reminder, and training mode prompt.

Some Expected Actions are linked to Tasks in multiple Functional Areas. For example, the Incident Commander, Firefighting, and Hazmat Functional Areas all have the Task "Approach scene" which can be fulfilled by the Expected Actions "Establish Entry and Exit Corridors." It doesn't matter who on the scene gives the commands to establish the corridors. As long as the Expected Actions are fulfilled, everyone gets credit, although a footnote in the AAR will indicate who actually issued the commands, or whether the commands were issued more than once. AEAS assesses the response of the team as a whole, rather than the individual player.

The Assessment Summary is displayed and updated on the Controller Station as the exercise runs (see Figure 6). When the simulation ends, the assessment is written out and can be displayed in the AAR. The display can be sorted to show the Tasks with their Expected Actions grouped by Functional Area, in chronological order, or as a list of unique Expected Actions. The last is useful as an overview, since some Expected Actions are linked to Tasks in several Functional Areas.

Assessment, Training, and Prompted Play Modes

During the domain engineering phase of AEAS, the subject matter experts realized that many of the scenarios involved WMD events that local Emergency Responder and EOC jurisdictions have little or no training for. Dealing with a dirty bomb or a smallpox release requires specialized knowledge to decide what kind of quarantine and decontamination procedures should be followed. It is desirable to lead the players through a "best decision" scenario, but to give the greatest teaching value, the scenario should be responsive to the decisions made to date rather than being pre-scripted. Driving the scenario with the Expected Actions made this possible. The simulation can be run in "Prompted Play" mode. In this mode, when an Expected Action is activated, at the optimal time for the Action to be taken (usually just after it is triggered), a training prompt is displayed, indicating what should be done and why. This leads the player to issue the required commands at the optimal time in the scenario.

During "Prompted Play" mode, the Controller can stop and start the simulation to allow time for discussion. He can also rewind the simulation to allow the participants to replay parts of it. "Training Mode" is identical to "Prompted Play" mode except that the training prompts are not displayed. The Controller can still stop, start, and rewind the simulation. "Assessment Mode" is used for testing the player's readiness to handle a specific scenario, and requires that the scenario

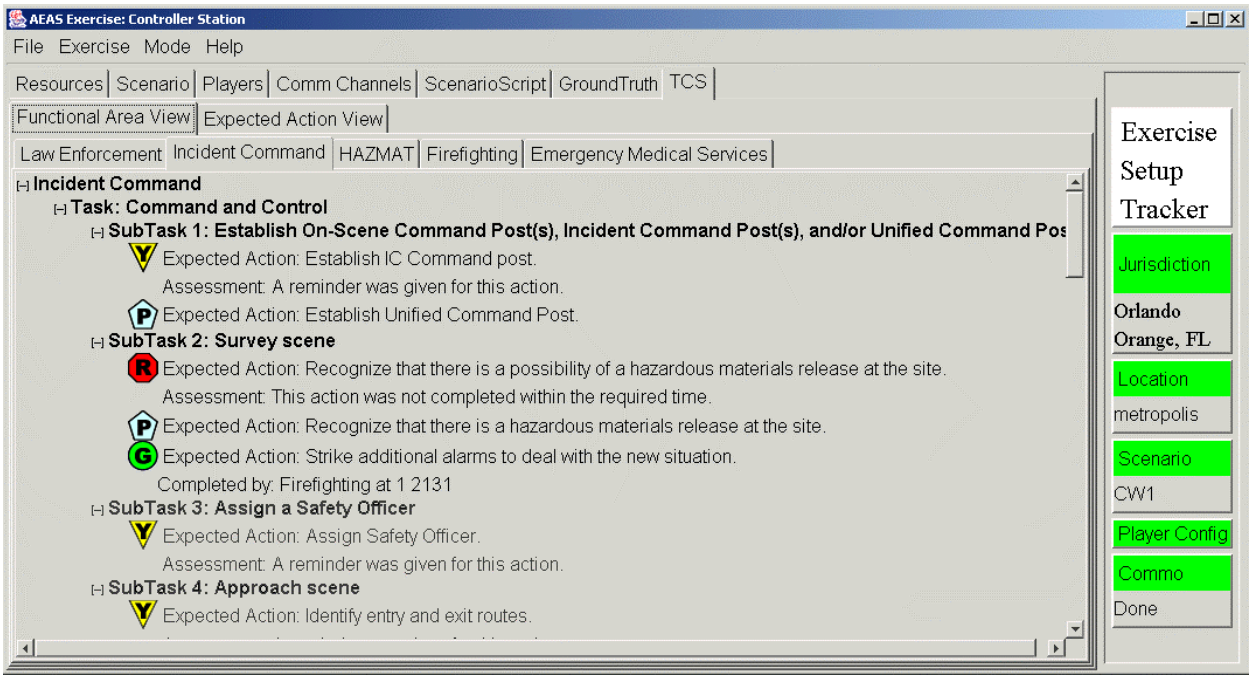

Figure 6. Assessment Summary on the Controller Station

be played through from beginning to end without the option to stop or rewind.

Other Assessment Criteria

The Assessment Summary will show how well the player handled the scenario "by the book." This assessment however, is only one method for showing how well the players dealt with the situation. Other criteria that are displayed in the AAR include number of victims, property damage, and resource allocation and usage at each timestep, to include number of responders assigned or unassigned and supply consumption levels. These curves can be compared to the statistics generated by using the "optimal" prompted path.

SIMULATED PLAYERS AND STIMULI

There are 41 Functional Areas defined to play in each scenario, and each Functional Area could be split among more than one player. This means the pool of players required to run a scenario can be quite large. Time, space, and resource constraints dictate that the scenarios be playable with fewer humans in the room. To accomplish this, some of the Functional Areas must be simulated. By having the Expected Actions drive the simulation, this is possible.

Simulating Players

The Expected Actions already define what commands each Functional Area player should give, and the optimal times at which they should be given. The simulated entities simply have to issue the correct commands at the correct time in the simulation.

In some cases, however, the commands require cognative input. To establish a staging area, for example, a location is needed. Project time constraints preclude building a simulated entity that can do a terrain and threat analysis to determine where the staging area should be located. Therefore, limits are placed on what Functional Areas can be simulated. Those with several Expected Actions that require spatial reasoning or other artificial intelligence are designated as required to be played by a human. Those with few or no such Expected Actions can be played by a simulated entity. The few Expected Actions it cannot handle are simply passed up to its superior by way of a radio or email message – "Hey boss, where should I put the staging area?"

This same mechanism is used to provide "Simulated Support Functions" (SSF) such as the FBI, National Guard, or Center for Disease Control. A set of Expected Actions is defined for the support function, and the function is always a simulated player. The players can interact with the simulated support functions by asking questions from a set of questions, or requesting assistance, and receiving messages from the SSF. For example, in the smallpox scenario, the Public Health player can send a clinical sample to the CDC. This will trigger Expected Actions for the CDC to respond with results, dispatch an epidemiological investigation team, and give recommendations to the Public Health player about how to proceed.

Chaff

One of the training goals of AEAS is to generate discussion among the players about how to handle problems that arise during the simulation. Some of these problems have no clear-cut answer, or the best answer will vary from jurisdiction to jurisdiction. Also, it is important for the players to learn to distinguish the important decisions and actions from the details that can consume time and resources.

To accomplish this, a Chaff message database was created (see Figure 7). Chaff messages are reports or bits of information that are sent to the players. Chaff messages can trigger Expected Actions, or they can be "noise" injects that require no response from the player. The controller sets the amount of chaff for a training run. Chaff messages can be sent by any communications channel used in the simulation, such as radio, email, or phone. They can be sent randomly, or triggered by events in the simulation. Once they are triggered, they have a timespan during which they would be appropriate. A Chaff message might be from a Law Enforcement responder, indicating that he has a report of a suspicious package on the scene. This was a common message in the Oklahoma City bombing, as nervous civilians looked for secondary devices. The Chaff message would have a trigger of

"conventional explosion" and a lifespan of a few hours. The Chaff could be sent at any time during its lifespan. If the lifespan expired before the Chaff was sent, the Chaff trigger would be reset to listen for another explosion.

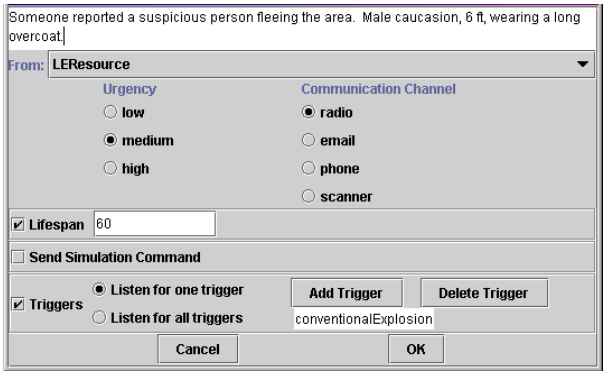

Figure 7. Chaff Database editor

CONCLUSIONS

Defining Tasks and then breaking down Tasks into Expected Actions has multiple benefits. First, a method for assessment is defined. Second, a method for simulating a Functional Area is provided. Third, knowing what the players should do allows for reminders to provide varied and valuable feedback.

AEAS is scheduled for delivery to local jurisdictions – every county in the United States – in the first quarter of 2003. Follow-on work could include creation of new CBRNE scenarios, and support for new scenario types, such as cyberterrorism. Enhancements may also include geospecific locations based on GIS data so that responders can train on a scenario that takes place in their own jurisdiction, and expansion into other response communities. Because of the design flexibility that allows users to create their own resources and command structures, AEAS could be especially suitable for training unconventional command hierarchies such as those found in Special Forces.

ACKNOWLEGEMENTS

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