SIMULATION TECHNOLOGY AND OPA 90 MANAGEMENT TRAINING FOR OIL SPILL CRISES

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ABSTRACT: *This paper investigates the application of computer simulation technology to the discipline of oil spill response management. Since June 1993, the Center for Marine Environmental Protection and Safety has operated a simulation facility for oil spill management training and exercises. The training programs include programs tailored to meet the training requirements and demands of maritime industry qualified individuals and spill management team members.*

This paper discusses the center's application of oil spill simulation to industry OPA 90 training programs, and to the conduct of exercises under the OPA 90 Preparedness for Response Exercise Program (PREP). The requirements needed to support simulation exercises and the limitations and benefits of oil spill management simulation are reviewed.

The Center for Marine Environmental Protection and Safety (CMEPS) at the Massachusetts Maritime Academy was established in the fall of 1992 and is dedicated, as the title indicates, to the training of persons from the maritime and related industries in subjects related to protection of the marine environment and to safety in marine operations. Its primary focus to date has been on providing management-level training and exercises to meet the mandates of the Oil Pollution Act of 1990 (OPA 90); that law requires marine transportation-related facilities and tank vessel owners and operators to be fully prepared to mitigate oil spills originating from their facilities or vessels. Programs have been developed to address the training requirements for various levels of responsibility, ranging from the owner or operator through the qualified individual to shore-based spill management team personnel.

A cornerstone of the center is its unique oil spill management simulation facility (OSMS). The OSMS uses visual-based simulation technology to provide an environment where students can exercise their learning in spill management and control in a realistic and challenging manner, and it serves as a sort of final exam for classes. The OSMS also is a vehicle for the conduct of spill management team training exercises and response plan evaluation; in addition, using recently developed, portable, linked communications and simulation equipment (termed "remote node" [RN]), the OSMS now supports off-site spill management team exercises.

The application of computer-based simulation technology to support training and spill management team (command post) exercises is relatively new. Its principal utility is in providing support for exercise control, in part through a real-time dynamic "electronic chart" view of the spill situation; in systems employing a three-dimensional visual representation of the spill situation, it allows for expanded participation for the operational components of the spill management team (SMT). It eliminates a significant weakness found in traditional table-top spill response exercises: the absence of a suitable visual representation of the character of the spill and the response efforts mobilized for it. Without such a reference to provide a uniform and incontrovertible "exercise truth" for exercises, uncertainty and controversy often result. Such controversy greatly reduces the realism, and therefore the effectiveness, of the exercise.

OSMS (simulator) structure and operation

The OSMS was built according to the specifications of the Norwegian state spill response team (SFT) and was manufactured by NorControl Simulators of Horton, Norway. This simulator is the first of its kind in the United States and remains one of three of its kind in the world. Developed under grants by the Norwegian government to meet both the drill and operational requirements of SFT, the first of these simulation facilities was installed at an SFT headquarters near Horton, Norway, and has been widely used for training of spill response personnel in the Norwegian government. Simulator databases have been developed for the Oslo Fjord in Norway and the port of New York. Additional OSMS port areas in development for near-term delivery include Portland, Maine (December 1996), Prince William Sound, Alaska (early 1997), and Halifax, Nova Scotia (early 1997).

The oil spill management simulation (OSMS) facility, as depicted in Figure 1, is composed of a command center linked by communications to the simulation room, which supports the operational components of a spill response, and to exercise control. The simulation room contains a series of workstations (at-scene rooms #1 through #6) that provide three-dimensional visual realistic perspectives of a single developing spill situation as it would be seen or experienced by the operational components of the team, as well as three modules (navigation, resource, and oil) that together control the simulation environment.

"At-scene #1" room is equipped for use as a field command location for the operations chief and/or staff. At-scene rooms #2 to #5 provide for participation of task forces or team members assigned to monitor or direct spill activities as directed by the operations chief. At-scene #6 provides an aerial platform. Each "at-scene" room is furnished with a large video screen depicting a view from wherever the occupants are located, as well as telephonic, VHF, and facsimile communications. From a given location on land, air, or water, the perspective viewed from an at-scene booth will change in a time frame realistically representing the time it would normally take to make such a change. For example, from the helicopter/aerial workstation, at-scene #6, the perspective would change on the basis of the chosen speed of the helicopter, its altitude, and one's direction of view. During exercises this workstation enables participants to conduct flyovers within the gaming area (simulation environment) to obtain overviews of the situation, gather intelligence respecting the spill, and/or direct response activities. Another at-scene booth might serve as a response vessel that is providing a view from its position, which would change in accordance with the speed and course of the vessel.

The resource module consists of data banks of equipment, material, and other resources available to the response in the selected port area, as well as telephonic links to the command center and the "at-scene" rooms. This module is manned by simulator operators and experienced

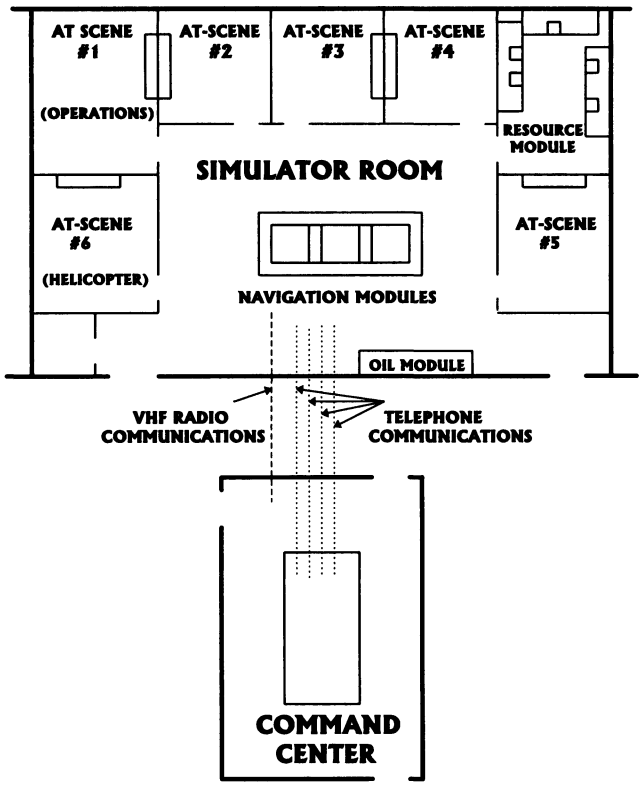

Figure 1. Layout of the oil spill management simulation (OSMS) facility at the Massachusetts Maritime Academy

"guests" (i.e., role players as Coast Guard personnel, media personnel, environmentalists, etc.) brought in for particular drills. This module is equipped to receive telephone calls on more than 100 different telephone numbers. Additionally, telephone numbers can be changed to reflect a change in port (gaming) area or to incorporate numbers from a specific response plan. Computer stations provide exercise controllers with data on the resources available and maintain an inventory of deployed resources.

The oil spill module (OSM) is a computer workstation on which run a series of interrelated models that control and automate much of the simulation. These models determine the behavior and fate of the spilled oil and keep a running inventory of the amount of oil spilled, the amount of oil recovered, daily response costs, and other relevant data. Additionally, the OSM continuously updates the navigation module with the spill's position and spread.

The heart of the simulation is run by trained simulator staff operating three "navigation modules." These modules provide the operators with an overview (electronic chart) of the waterway with all navigational aids and deployed response resources indicated and, through telephonic or VHF link, provide communication with the operational elements (operations chief and task forces) and the resource module (exercise control). The navigation modules provide the means by which the teams can access resources and deploy, navigate, and operate equipment in response to the spill. Exercise scenarios (selection of oil type, initial environmental conditions, spill cause, and amount and rate) are created using this module, and it also allows operators and controllers to alter wind and current forces acting on the spill, freeze the response to review actions, or reorient the response and memorize activities to specific points so that the response can be "backed down" and rerun from a particular point.

The command center (the operational command center for the spill response), which houses the responsible party's representative (the qualified individual, or QI in OPA 90 parlance), members of the spill management team (SMT), and state, federal, and other involved entities, is located away from the simulation room on the ground floor of the Harrington Building. The command center is provided with charts, status boards, and communications and other equipment necessary to its function. As in actual events, the communications provide a means by which the SMT can access spill response resources (oil spill removal organizations), government officials, media, the public, and other involved persons and organizations; receive information; and provide direction and receive feedback from the operational components of the response team in the field.

As members of the SMT either located in the command center or deployed in the field (simulation room), students or players can, for example, oversee or direct the protection-sensitive areas or oil removal projects, practice cost accounting, and make periodic reports. Instructors or controllers can in turn alter parameters and activities in response to student countermeasures to mimic real-world unpredictable changes in conditions. Because the operations chief and/or task forces interact through the navigation modules rather than directly operate response resources, the activities of a spill management team occur realistically.

For example, if the QI or unified command strategically determines that a particular shoreline must be protected, the spill manager (incident commander) will determine, through logistics support, what resources are available (from the resource module/OSRO) and, using planning support, develop the requisite tactics. The spill manager will direct the operations chief to deploy the resources necessary to accomplish such protection, who in turn will then direct one of the task forces (Task Force #3, for example) to execute those tactics. Task Force #3 will then direct the resources under its command, through communications with the navigation module controllers, to deploy and operate resources as may be necessary to execute the designated tactics, drawing on resources allocated for the operation by the command center through the resource module. To execute the strategy outlined in this example, Task Force #3 would review the tactics developed in the command center by the planning section and, through the navigation module, direct the ordering of the resources designated for the project and give instruction for deployment of those resources in accordance with the tactics developed. The activities thus far appear graphically in Figure 2.

For a given strategy, such as protection of a shoreline, the resources ordered up would typically include oil boom, anchors, buoys, line, small boats, and vessels or vehicles to transport the resources to the site. From the operations chief (and through communications with the navigation module), Task Force #3 would have an inventory of the required equipment along with the locations(s) of that inventory. It would have to develop a plan for obtaining the required resources, vessel(s), and vehicle(s) from an optimum source, for organizing and scheduling transportation, and for transporting the resources to the most feasible deployment site(s). The SMT would then order the required resources and instruct the OSROs of the transportation equipment (through the navigation module) to collect and transport the resources to the selected site and, when there, to deploy or operate the resources as necessary. A graphic representation of this strategy is given in Figure 3.

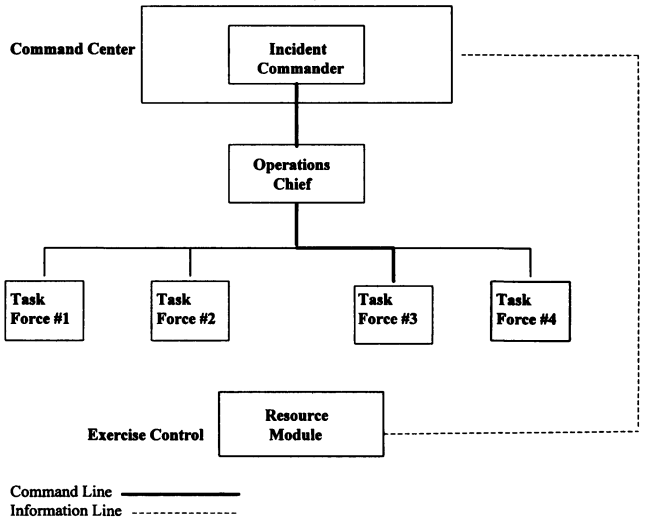

Figure 2. Line of command for sample strategy

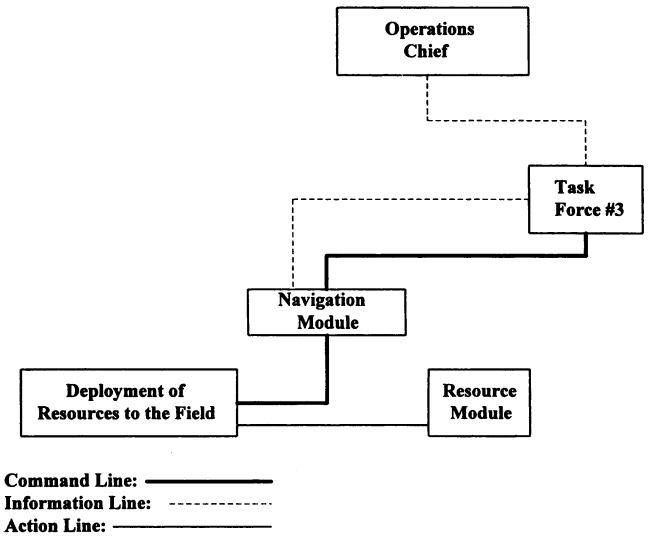

Figure 3. Outline of Task Force #3 activities

Training programs

The center's OPA 90 programs have been developed and offered to address the training requirements for various levels of responsibility from the owner or operator through the qualified individual. Initial training programs (for students attending a center program for the first time) are developed around a core curriculum that includes such lecture topics as the following:

- The role and responsibilities of the qualified individual
- Media relations and management in a spill situation
- Legal, regulatory, and company requirements
- Implementation of the (vessel or facility) response plan
- Properties of petroleum hydrocarbons
- Effects of spilled oil on the environment and economy
- Shore-based spill management
- Legal aspects of responding to a marine casualty or pollution incident
- The impact of oil on coastal ecosystems

Programs typically consist of several days of lecture followed by a one-day, end-of-program simulation exercise. For the exercise portion of the program, each student is assigned a specific role as part of a spill management team (SMT) (under the incident command system [ICS]), and each team must fully manage the response to a simulated spill. These exercises are designed to test knowledge gained during lecture, develop team building, and allow persons to develop and/or improve oil spill crisis decision-making skills. The focus of the initial exercises is on the emergency phase. Our goal is to create the atmosphere of crisis that normally exists in the early stages of response to a significant spill and to provide participants with a realistic expectation of the "stakeholders" involved, their roles and expectations (or demands), and decisions that the management team will be faced with in an actual event.

Classes that include simulations are limited to 15 students and usually represent a cross section of the maritime industry, such as facility and vessel owners and operators, cargo owners, salvage companies, ship agents, regulatory personnel, harbormasters, and marine surveyors. Programs are typically attended by persons with varying experience, from seasoned spill management professionals to persons with no experience. Consequently, students (and faculty) learn not only from lecture and the exercise, but also from the interchange of information and ideas with other students in the program. Simulation SMT roles for exercises are generally not assigned but rather are selected by lottery. After their roles have been selected, students are free to swap positions before the exercise starts.

Advanced programs ("refresher" courses) are offered that expand upon knowledge gained in initial or previous refresher programs. These annual refresher programs vary yearly and typically consist of a regulatory update, case studies, a spill management team exercise using the OSMS, and advanced lecture topics. The OSMS exercises in advanced programs often are designed to begin hours or days into a response and to place greater demands on the team. Examples of lecture topics in annual refresher programs include the following:

- Economic assessment of natural resource damages
- Salvage considerations
- The P&I Club
- Documentation and disposal of oil
- Cost documentation and control
- The unified command structure

Simulation exercises

The OSMS can provide enhanced realism from that achievable in traditional command post exercises. However, it is simply a tool. Effective exercises require extensive planning and preparation and must be staffed by knowledgeable role players. Exercises must challenge the participants, and we typically tailor the exercises, in terms of difficulty and management requirements, according to the experience of those participating. Some of the ingredients for an effective exercise include the following:

- A credible scenario
- Clear objectives
- Realistic and appropriate events
- Trained and spill-experienced role players
- Clear expectations for exercise participants

The purpose of an exercise is usually twofold. An organization or team is exercised in scenarios that attempt to duplicate actions in as near real situations as are likely to be encountered (credible scenario). The purpose is (1) to familiarize the organization or team and its members with both overall responsibilities and objectives and the individual duties and relationships of the members to one another; and/or (2) to test response plans in realistic situations and conditions.

An exercise will normally involve three main groups of people: participants, controllers, and role players. At times evaluators and observers will also participate or be present at an exercise; however, they normally will have no direct play in the activities. It is imperative that each of these groups receive proper briefing in the use of the OSMS and their responsibilities in advance of the exercise.

Participants. The participants are the individuals being exercised (students, industry or government SMT). They constitute the organization or team against which the exercise scenario is conducted. They will not normally be privy to any advance information concerning the scenario itself but are expected to respond with the information that would normally be available to them if they were experiencing a real spill situation. Advance briefing concerning the OSMS is limited to the use of the simulation room at-scene booths, communications, and initial positioning (location for the exercise). Participants are also provided with materials and information such as response and area contingency plans, communication rosters, and other materials that they would normally expect to have access to. In developing information beyond that given to them at the initiation of the exercise, participants should be encouraged to use the materials placed at their command in the same manner that they would have to if they were really faced with the spill situation. Any lack of such materials made known to the role players should be brought to the attention of the controllers unless such information would normally be available from an individual or organization being role-played.

Controllers. As indicated by their title, controllers control the execution and direction of the exercise. They serve as the designers of the exercise and function to initiate the exercise and implement the scripted input into the developing scenario. They should be largely invisible to the participants but should maintain sufficient oversight to be able to monitor development of the scenario and response by participants and to alter or adjust development of the scenario to deal with unfolding events and/or deficiencies in its implementation. In our simulator-supported exercises at the academy, the controller roles involving response activities of OSRO(s) are filled to a large degree by the simu-

lator instructors, who operate the simulator and receive direction from the participants to activate and position ordered resources.

Exercise truth. Exercise truth functions to keep track of and control the facts in an exercise. Without such controls, a wide gap between the actual exercise facts and the facts perceived by the participants will rapidly open, and control over the exercise will deteriorate. Exercise truth is accomplished in conventional exercises by establishing an exercise truth center through which all directions and requests for resources by the participants are routed and in which records of all resulting activities are maintained. In spite of the maxim that "nothing has happened unless it has gone through exercise truth," there are often communication breakdowns that lead to gaps between actual and perceived facts; these gaps lead to confusion and reduce the control and realism in the exercise. Staffing and manning exercise truth is also quite labor-intensive in large conventional exercises. In our simulator, exercise truth is accomplished by the simulation models and instructors' or controllers' inputs. Exercise truth is maintained very realistically by the simulator; if it doesn't show up on the simulator visual, it hasn't happened or doesn't exist.

Role players. The role players are people playing the role of individuals or organizations that normally interface with the spill management team or participants responding to the spill situation. Roles normally included in spill response exercises include OSROs, state and federal government officers, irate citizens, underwriters, damaged claimants, environmentalists, and so forth. Depending on the staffing of the exercise, an individual role player may be called upon to play the part of more than one individual or organization. To the extent possible, we use persons in roles that reflect their actual experience, and have received substantial support from the USCG and state departments for the roles of federal and state OSC, respectively.

Role players in spill response exercises play an extremely important part in establishing realism in spill response scenarios. For this reason, it is critical that each role player is familiar with the port area for the exercise, understands his or her specific role, understands the normal behavior and motivations of the individual whose role he or she is playing, and can credibly act out the normal reactions of that individual to scripted and unscripted stimuli. To the greatest extent possible, the role player should be familiar with the normal duties and responsibilities of the individual being role-played, as well as the terminology and procedures usual in the role. In acting out their roles, role players should try to put themselves in the place of the individual being role-played, as if the scenario being enacted were occurring in reality, and should attempt to respond to events or input from the participants in the way they would envision responding if the event or input were in fact really occurring.

Role players are instructed to remember at all times that they are performing as part of a scenario and acting out elements of that scenario that are crucial to the realism imparted to participants in the exercise. They should be careful to remain in their roles and not come out of them to comment on the performance of the participants, shoot the breeze, or critique the exercise. Any shortcomings in performance or problems with the exercise or scenario should be made known to the controllers and/or saved for a critique at the end of the exercise. Any deviation from a role by the role players affects realism and can seriously degrade the performance of the participants and detract from the value of the exercise.

Remote-site simulation capability (remote node)

The remote node (RN) is a portable simulation system driven by the OSMS at the academy that is designed to provide full-capability OSMS exercises at locations anywhere in the world. The initial impetus for its development was the requirement that the center, as a condition of its USCG funding to purchase the OSMS, conduct area management team exercises (as defined under the Preparedness for Response Exercise Program [PREP]) in two East Coast COTP zones. The RN allows for greater participation possibilities for training exercises. The remote node is illustrated if Figure 4.

The OSMS remote node was developed to the Massachusetts Maritime Academy's specifications by the Raytheon Company and employs distributed interactive simulation (DIS) technology, which allows persons at different locations to participate in (and view) the same simulation exercise. It uses data generated by the academy's OSMS, which are fed via telecommunications link to the locale of the node to regenerate the images and dynamically display them on the node's representational screens and on a two-dimensional, chart-like, "bird's eye" overview. The representational screens depict selected "real-time" views of the spill area from helicopters and/or response vessels for the trainees. The electronic chart view is used exclusively by exercise control to display an active, chart-like, "real-time" representation of the exercise area that locates the spill and deployed resources. Concurrent telephonic and simulated VHF linkups with the academy, remote node controllers, role players, and others provide realistic full-voice communications as required.

The remote node of the OSMS was proven in its first field deployment in support of a Coast Guard SMT area exercise in support of the Captain of the Port (COTP) New York in October 1995. The remote node provided three-dimensional "overflights" for a simulated bunker spill from a collision between barges and a dry cargo ship in upper New York Bay. From these "overflights," Coast Guard personnel being drilled were able to observe and evaluate not only the spread and drift of the spilled oil but also the deployment and activities of the response resources working the spill. With this tool, they were able to clearly and realistically track the spill, the resource locations and cleanup, and the results as the response progressed.

Biography

David C. Barry is Assistant Director for the Center for Marine Environmental Protection and Safety at the Massachusetts Maritime Academy. Mr. Barry holds degrees in chemical and civil (environmental) engineering. He has participated in the management of a number of marine oil spills, including B. T. *Nautilus* (1990) in New York Harbor.

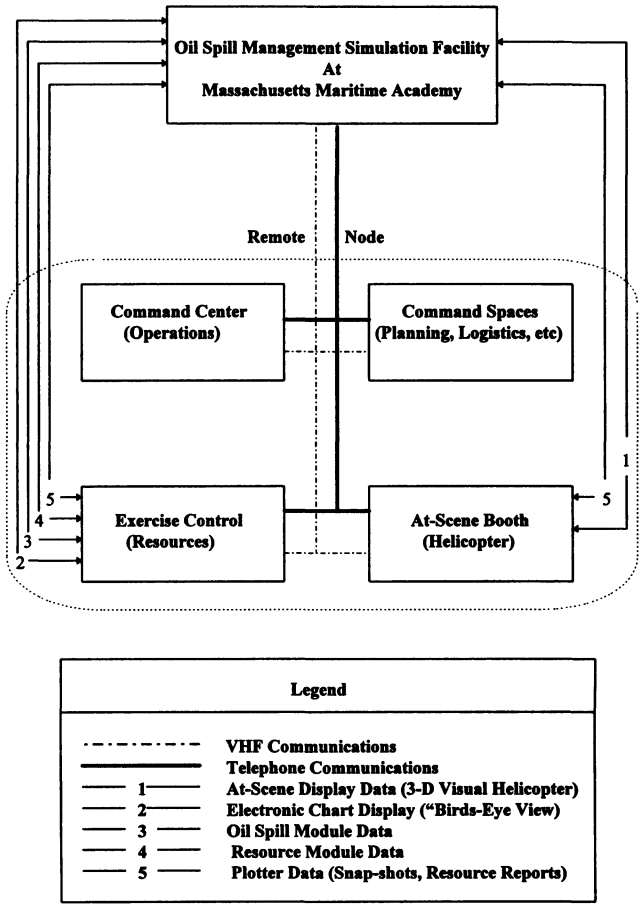

Figure 4. The remote node (RN) simulation system