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Cost-Reduced Methods of Using the Mass Maritime Oil Spill Management Simulator (OSMS) in Alaskan Spill Exercises and Training Sessions

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1.0 Introduction

The Oil Spill Management Simulator (OSMS) at the Massachusetts Maritime Academy has been significantly enhanced by the addition of a portable Remote Node which enables seamless visual connections to OSMS data files in Massachusetts and verbal communications with system Controllers in Massachusetts or elsewhere. Using the Remote Node and having the coastal characteristics of, for example, Prudhoe Bay, Cook Inlet, and Prince William Sound, would enable the simulator to be utilized in Alaska without the high costs of system purchase, maintenance and system operators. Other options, including purchase of a full OSMS system and development of an Alaskan Center having their own Remote Node, are also discussed.

2.0 History of Development

The OSMS at the Center for Marine Environmental Protection and Safety (the Center) within the Massachusetts Maritime Academy is unique in the United States. Only two others are present worldwide: one in Norway, the other in Spain. The Norwegian State Pollution Control Authority developed the original design specifications, after which modifications were made for the U.S. system, particularly to include the ability to model new geographic areas. The three systems were manufactured by Kongsberg NorControl AS of Horton, Norway, a well-known developer of ship simulators.

An advantage of using the NorControl system is that visual and geographic data files are interchangeable between the OSMS and those developed for their 2000 series ship simulator. To date, spill-related data files have been developed for New York Harbor, Portland (ME), and Oslo Fjord in Norway. Boston Harbor is under current development by the Center.

Massachusetts Maritime Academy maintains a dedicated facility for the simulator. In addition to multiple control panels there are six separate "At Scene" booths, each of which is able to provide a different view of the incident (e.g. helicopter, response vessel, portside staging area, etc.). VHF radio and phone communications from the booths enable participants to operationally direct all response resources.

Historically, most training using the OSMS system has been conducted at the Center in Massachusetts. However, as many groups expressed a distinct need for a portable system to support their oil spill exercises at other locations, the Center developed specifications for a "Remote Node" system. Principal among these specifications included the capability to receive complete 2- and 3-dimensional visuals supported by seamless hand-held radio communications. Raytheon, noted for its military communications networks, completed the hardware construction and software installation to make it real in 1996. The capabilities of the Remote Node have particular application to support response exercises in Alaska.

Funding for system development (fixed and portable) has come from the Government of Norway, the U.S. Coast Guard, and the State of Massachusetts. Previous reports on the OSMS were published by Barry (1997) and Gallagher and Barry (1994). The system User Manual provides further technical details and was published by Kongsberg NorControl AS (1996).

3.0 Components of the Oil Spill Management Simulator (OSMS)

The simulation environment is maintained by interaction among five principal components:

- The Navigation Module,
- The Visual System (with At-Site Stations),
- The Resource Module,
- The Oil Spill Module, and
- The Communication System.

During an exercise, the simulation is run by a trained staff operating all components to realistically project both the visual nature of the event and the verbal communications needed to direct and control all operating elements (e.g. skimmers, helicopters, booms, shoreside cleanup, etc.). Real representatives of the U.S. Coast Guard and state government commonly participate in the exercise which further enhances realism.

Each of the major system components is briefly described below:

3.1 The Navigation Module

The Navigation Module is the primary controlling interface to the system and is based on the computer system that runs ship simulators. It computes and sends out for display all images of the incident based on internal calculations and input from the other OSMS components. Initial setting are input here for the spill scenario, including the:

- selection of oil type,
- initial environmental conditions (currents, visibility, wind, and sea state),
- spill cause (e.g. collision, grounding, etc.), and
- discharge amount and rate.

As the incident progresses, it is displayed 2-dimensionally for Controllers and in 3-dimensions for participants. All vessels and water-borne equipment movements are controlled by the OSMS operators, primarily in response to the directions of exercise participants. Input is received from other modules (e.g. updates of oil position and weather conditions from the Oil Spill Module) and is immediately displayed.

System Controllers have the capability of altering winds and currents, freezing the response to review actions or re-orient the response, and to memorize activities to specific points in the response so that it can be "backed down" and re-run from a particular point. Freeze-frames (2D and 3D) are always "grabbed" in the computer and used for debriefing the spill exercise to illustrate the progression of the response and indicate the location and timing of all key events.

3.2 The Visual System (with At-Site Stations including a Helicopter Station)

The visual display of the incident is the most-important feature of the OSMS. This system is unique to the U.S. in that 3-dimension visual files of the selected spill area are created and displayed by the system. At the Center, the OSMS system has six At-Scene stations that can be utilized during the exercise (e.g. to illustrate the view from the stricken vessel's bridge, from aboard an oil spill recovery vessel, from a staging area, etc.), including one station dedicated as a helicopter station. The system generates a unique image for each station that accurately represents the view in 3-dimensions from that site. For instance, the size and viewpoint of the shorefront buildings and on-water vessels change as the helicopter lifts off and overflies the stricken vessel. Controls to the helicopter station include speed, altitude and direction.

While exercise participants view the system in 3-dimensions, exercise Controllers access 2-dimensional images with zoom capability that contain all information as an overview of the spill situation. The 2-dimensional views are similar to that of electronic charts showing the shoreline, buoys and other navigational aids, and major geographic features with the addition of the location of the oil spill and all vessels (response, stricken, and others).

3.3 The Communication System

The ability to not only see the spill but to communicate with all responding vessels, equipment suppliers, state agencies and others, adds significantly to the realism of an oil spill exercise. To this end an extensive array of communications is maintained at the

Center's OSMS including numerous telephone lines, fax lines, and VHF radio connections.

During exercises, communications commonly occur between the Incident Command Post and the helicopter, response vessels, the stricken vessel's Captain, equipment suppliers, representatives of State agencies, environmentalists, the U.S. Coast Guard, and the press. Communications also flow between At-Scene personnel and the helicopter. Examples of such communications may include reports to the Incident Command Post regarding visual observations made of the spill, updates from a field staging area on the progress of a particular operation, and directions from the Incident Command to a skimmer vessel or staging area.

3.4 The Oil Spill Module

The Oil Spill Module is contained on a computer workstation running a series of interconnected models which control the distribution and fate of the spilled oil. Three models comprise the Oil Spill Module: the Oil Drift Model, the Shore Model which has three sub-models (Shore Cleanup, Damage, and Economics), and the Environment Model.

The Oil Drift Model calculates:

- trajectory – consisting of advection and spreading which control overall slick movement;
- oil weathering – affecting the quantity remaining after evaporation, entrainment, and emulsification, based on weather, sea conditions, and oil type;
- impact on shorelines – oil retention as it hits various types of shorelines;
- oil retention behind boom and skimmer systems;
- oil recovery by response activities (e.g. skimming); and
- the effects of chemical dispersion.

From these components, an oil budget is generated and updated throughout the exercise. The oil budget provides the following breakdown of oil quantities:

- spilled
- drifting
- dissipated
- chemically dispersed
- skimmed
- close to shore
- evaporated
- contained in booms

Retention by booms is based on the boom type and sea conditions. Four types may deployed: light port boom (0.5 m draft), medium port boom (0.8 m draft), medium offshore boom (1.5 m draft), and offshore boom (1.8 m draft). Boom retention can be further adjusted downward from model calculations using an operator-input efficiency multiplier varying from 0 - 100%.

Similarly four skimmer types may be deployed, differing in their ability to handle thick oils (0.5 to 0.15 m thickness) and in the amount of free water collected (factors vary from 0.1x to 1.0x the amount of oil recovered).

As oil particles get close to shore, 10 percent of the particles are passed "close to shore" to serve as input to the Shore Model. The remaining 90% are repositioned to remain out of the "close to shore" category to reproduce along shore oil transport (i.e. movement up the coast on a flooding tide). The Shore Model has 9 zones into which oil will be positioned on the shore (e.g. in the tidal zone, upper sediments, oil in deep sediments, etc.). Oil in the tidal zone is subject to resuspension.

Additionally, as initially developed by Gundlach and Reed (1986), shoretypes are defined along the coast, each having a run-off coefficient that indicates oil retention after removal by natural processes. Shoretypes include rocky, boulder, sandy, salt marsh, and constructed (e.g. riprap). If desired, a Shore Cleanup Model is available which calculates amount of recovered oil based on equipment used (rakes, shovels, tractors, excavators, etc.) and the type of shoreline.

The Oil Damage Model keeps track of the length of polluted coastline, number of birds damaged, and number of aquaculture sites impacted. This, and the Economics Model which calculates cost of the incident, are rarely used during exercises conducted at the Center.

The Environment Model sets the geographic database and environmental conditions, including tide and/or river conditions, depth and topography, and wind conditions.

3.5 The Resource Module

The Resource Module consists of a data bank of equipment, material and other resources available to the response within the selected port area. Personnel manning the Resources Module are equipped to receive calls on numerous telephone lines. Additionally, for exercises held at the Center telephone numbers can be changed to reflect a change in port (gaming) area or to incorporate numbers from a specific Response Plan. Several computer terminals provide exercise Controllers with data on the resources available and maintain an up-to-the-second inventory of the resources deployed.

4.0 The New "Remote Node" System

The Remote Node is a portable oil spill simulation system driven by the OSMS system at the Center. Being portable, it is designed to enhance and support spill training exercises anywhere in the world.

The initial impetus for development, supported by U.S. Coast Guard funding, was to support Area Management Team exercises as part of the Preparedness for Response Exercise Program (PREP). Initial testing and implementation occurred in New York Harbor and Portland, ME, during 1996 and 1997, respectively.

4.1 The Application of Advanced Technology

Going portable with such a complicated and computationally intensive system is not simple. Connections to the mother computer have to be maintained in both directions. In one direction, dynamic information is obtained from the mother computer to update both the 2- and 3-dimension displays, and conversely keyboard inputs which change resource positioning send digital data to the home computer in the other direction. And this needs to be seamless with no noticeable time lapse between when the command is made and the image received. In addition, the Remote Node not only needs one terminal, but multiple terminals to support At-Site displays (e.g. helicopter and a response vessel) and the 2-dimensional overview for exercise Control.

In order to do this, Raytheon utilized Distributed Interactive Simulation (DIS) technology which allows persons at different locations to participate in (and view) the same simulation exercise. In response to commands from the Remote Node, data are generated by the Center's OSMS and sent via a telephone link to the offsite location which then re-generates real-time images of the spill situation. Images are then dynamically displayed in 3-dimensional format for participants located in At-Scene stations, and in the 2-dimensional chart-like overview for Controllers.

From the Remote Node, time-stamped snapshots of the electronic chart and At-Scene displays can be taken to facilitate the debrief and enable participants to see the locational history of the spill and the results of their actions over the course of the exercise.

At the same time that image data are being transferred, realism is further maintained by having fully inter-connected radio and telephone communications. VHF radio communications through a handheld radio are passed to phone lines and back to the Center's staff or to professionals from the exercise who may be located elsewhere. Responders can all talk to each other from various locations (e.g. the helicopter booth, a staging area, or the Incident Command Post) and to the staff "manning" the vessels and aircraft that are responding.

Lastly, all information regarding the call-out and deployment of response resources is maintained in the Resource Module on a separate computer, independent but connected to the Center via the Remote Node. In this manner, a local database of resources can be managed at the exercise site by the local professional most familiar with these resources. Once equipment are deployed in the Resource Module, data are passed to the Center for entry into the spill site display. Equipment then appear simultaneously in all visual displays in Massachusetts and at the site of the Remote Node.

5.0 Using the Simulator and Remote Node to Support Training Programs

The Oil Spill Management Simulator at the Academy actively supports a variety of oil spill training programs, primarily in response to OPA-90 requirements. Professionals from various background and professional level attend these programs, which include such topics as:

- 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,
- Incident Command System (ICS) Training for Spill Management,
- Legal Aspects of Responding to a Marine Casualty or Pollution Incident, and
- The Impact of Oil on Coastal Ecosystems.

Programs typically consist of several days of lecture followed by daylong simulation exercise. For the exercise, each participant is assigned a specific role as part of a Spill Management Team working under the format of the Incident Command System (ICS).

Advanced "refresher" programs typically consist of an regulatory update, case studies, advanced lecture topics, followed again by a one-day simulation exercise. The OSMS exercise during these programs commonly begins hours or days into a response, and are designed to place greater demands on the responding Team.

The Remote Node greatly enhances the applications of the simulator. No longer does a full Spill Management Team have to come to the Academy for training. The cost savings of remaining at their base of operation are substantial, dependent on the number of trainees involved. Users of the portable system have included the Ports of New York and Portland (ME) and several industry sponsors, including operators in Alaska.

6.0 Using the OSMS System in Alaska

There has been discussion in Alaska on developing such a system in Alaska to support training and other spill-response programs. This section highlights three key approaches or options available to develop an OSMS system in Alaska. These are:

Option 1: The OSMS system is updated and installed in its entirety at a site in Alaska;

Option 2: The Academy's Remote Mode is utilized in Alaska as needed to support specific training exercises, with input of Alaska resource and geographic information; and

Option 3: An independent Remote Node is developed and installed at a training site in Alaska, utilizing local equipment information and local knowledge of the area to man the communications module.

6.1 Option 1: Developing a New OSMS in Alaska

Option 1 is the most ambitious and would include installation of a complete OSMS training center in Alaska. The Academy has invested close to $1.5 million in their system, which may serve as a cost estimate for this development. In addition to the initial outlay of funds for purchase and development, there are annual maintenance costs not only for the hardware and software, but also for the training staff and facility. The Academy program trains approximately 400 professionals annually with a core staff of three full-time and six part-time Academy and adjunct faculty.

6.2 Option 2: Updating the Existing OSMS Remote Node

Option 2 entails bringing the Remote Node of the Center to Alaska in support of onsite training. This has already been done at the SERVS facility in Valdez during the winter of 1996 and summer 1997, using New York Harbor and Portland, ME, as the spill sites, respectively.

In order to increase the relevance of the system to Alaska, the OSMS would be upgraded with Alaskan geographic information (e.g. Prince William Sound), and local response resources would be added to the Resource Module. Both tasks are relatively straightforward.

In addition to the visual and geographic file updates, communications must reflect local knowledge to make the exercise fully realistic. Three options are available to do so:

1. The Controller staff can be trained in key geographic locations and peculiarities of the local environment (e.g. via participation in vessel escort, fishing, or other marine-related activity);

2. A professional with local expertise can serve as an intermediary between exercise Control and Incident Command. The Controllers in Massachusetts would hear the communications and react accordingly – or the intermediary would verbally tell the Controllers where to move the specific piece of equipment; or
3. An intermediary with local knowledge could fly to Massachusetts and physically man the radio/telephone link in the OSMS center.

The costs involved for development of the new geographic data set and input of local resources is currently on the order of $75,000. Changes to the communications system are not included and need additional study. If an agreement for multi-year use of the OSMS could be made, the Academy is likely to jointly fund these system enhancements.

6.3 Option 3: Development of an Independent Remote Node in Alaska

This third case accepts that (1) the OSMS system with geographic and resource enhancements as presented in Option 2 are acceptable, and (2) that Alaska needs a full-time system for use in the State. With this premise, the Raytheon manufactured system would be duplicated. A base training Center would be established in Alaska with appropriate communications links and At-Scene booths. Two professionals are likely to be needed in Alaska to set up and maintain the system and to participate in training exercises. The estimated costs for this option would be those itemized in Option 2 ($75,000) plus purchase of at least five field units: a helicopter booth, another At Scene booth, a Control display, a Resource Module computer, and a Communication System. The communications package would direct calls to the Alaska Center (instead of to Massachusetts). To do this, an estimated $175,000 - $250,000 is necessary. Salaries for personnel and facility costs are additional.

7.0 Conclusions

The 3-dimensional simulation of marine areas offers significant training advantages for oil spill responders. The Oil Spill Management Simulator (OSMS) at Massachusetts Maritime Academy is the only oil spill simulator system in the United States offering 3-dimensional visual representations of the incident, supported by 2-dimensional Control images and interconnected radio and telephone communications. The development of a portable Remote Node, providing full image and communications capabilities, offers great flexibility in supporting training exercises outside of Massachusetts.

To support spill-response training in Alaska, this technology may be purchased outright from the manufacturers, or can be enhanced at a substantial cost savings to include information relevant to Alaska but using the core technology previously developed. The Center is particularly interested in working with Alaska on a long-term relationship to develop spill simulations relevant to Alaskan conditions.

8.0 References

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