Simulation Training To Meet Advances in Shipboard Automation

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We all know that the maritime industry does not adapt quickly to new technologies. Gradually, however, the shipboard environment has advanced to include such technologies as Automatic Radar Plotting Aids (ARPA), Electronic Chart Display Information System (ECDIS), Integrated Bridge Systems (IBS), Voyage Management Systems (VMS), joystick controllers, automated Engine and Cargo control rooms. These advancements have been developed in an attempt to increase safety, reduce the workload on the watch officer, and increase the quality of watchkeeping, however, it is important to note that if training is not provided for the operators of this equipment the opposite may result; decreased safety, increased workload, and decreased quality of watchkeeping.

One important phase of this training can be provided at a maritime simulation facility. These facilities provide a controlled environment where students can gradually learn, through a structured curriculum, the capabilities, limitations and operation of specific automation equipment without the obvious risk to the crew, vessel, environment, and passengers, if applicable. The simulators also provide an excellent "test bed" for designers and users to determine how to best utilize a particular piece of equipment or to evaluate between different manufacturers of the same type of equipment.

Recently, the Conference on Maritime Simulation (MARSIM) met in Copenhagen, Denmark, and discussions were held regarding the present status of simulation training and research. This international conference, which is held every three years, attracted over 200 participants from 25 countries. From this conference and subsequent visits to several European simulation facilities, it is evident to me that excellent simulation training and research capabilities exist world-wide and that the current state of simulation technology (hardware, software, courseware) can provide operators and designers of automated shipboard equipment with tremendous benefits. These facilities are constantly adapting their simulators and programs to incorporate new shipboard technologies and to meet new training regulations.

TRAINING METHOD

Obviously, when introducing a new piece of automated equipment into an existing training program, a training objective must first be clearly defined and then the training program built from that objective. You can not, for example, simply throw an ECDIS on the bridge simulator and continue the training courses as usual. By the way, this principle also applies to the ship itself; a shipping company should not expect to add new automation technology to the vessel without a clear objective of how and when this automation should be utilized.

When addressing training for operation of automated systems, it should kept in mind that the training requirements for the operators actually increase when automation is introduced. This is due to the fact that the individual needs to be trained in the use of the automation and also needs to be proficient in manual and backup procedures.

We all know the problems which can arise from relying solely on automation. A cruise ship grounding last year involved a failure of the position fixing input to an Integrated Bridge System, which went undetected for numerous hours. Although still under investigation, one can speculate that there may have been a sense of complacency on the bridge since the system had worked flawlessly in the past. This may have led to a relaxing of cross checking procedures with other navigation information.

As we all know from the Prevention Through People (PTP) program the vast majority of maritime casualties are the result of human error. It is important to realize, however, that the human who is responsible for the error is not necessarily the human operating the equipment. In some cases the error can be traced back to the people who designed the equipment or the overall system which incorporates the equipment. The error can even be traced back to the company in some cases for not providing an adequate level of training or not providing guidelines for when and how to use the equipment.

AVIATION COMPARISON

In the area of maritime training we are constantly looking to the aviation industry for comparisons since it has been quicker to adapt new technologies. In referencing Cockpit Resource Management, which is a compilation of papers on aviation training, some good lessons can be found. For example, in aviation it is interesting to note that initially when automation systems were added to training and check ride sessions, it resulted in an increase in the student failure rate. This was attributed to the fact that the students were not adequately trained on the automated systems before the sessions. This resulted in a revised training evolution which included:

- Generic automation training
- Simulator sessions without automation
- Extensive training on specific automation
- Simulator sessions with the use of automation at the pilots discretion

Several airline companies have adopted an automation philosophy which spells out what the company's stance is on the use of automation. A company may decide to leave it up the operator to determine in which situations the automation will be best suited and during which time it is better to use a more traditional method.

JOYSTICK EXAMPLE

As far as the training goes, we need to determine which training device should be used during which stage of the program. If we use the example above, it is best to train an individual on a piece of equipment in a stand alone mode prior to incorporating that system in a much larger system and complex training exercise on a full mission simulator.

As mentioned earlier, maritime simulators can be used to train on specific automated shipboard systems. Since equipment varies significantly from one ship to the other, unlike aviation, this usually involves hardware and software integration to the existing simulator. One example of customized integration to meet customer requirements is the installation of a joystick controller for a cruise company's training program at STAR Center. This controller combines the separate controls of the engines, rudders, and thrusters in a single control device.

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STAR Center's 360° Bridge Simulator equipped with Joystick Controller (inset)

To try and imagine how the officers might feel when a new piece of automation is added onboard their vessel, an analogy that almost everyone can identify with follows: Suppose you rent a car and instead of a steering wheel, accelerator, and break pedal, the car is fitted with a joystick which incorporates all of those separate controls. You are told that this makes driving the car much easier and safer. I think you would agree that without training, this device would definitely decrease the safety of the operation. An what could be said about your confidence level in using this device; I think it is safe to say that it would not be very high. If given the choice, I am sure that you would opt to abort the joystick if possible and use the traditional and familiar controls.

The cruise company saw the tremendous benefit to training their senior officers on this device in a controlled environment; the simulator. To meet this goal, an authentic joystick identical to that which is on board the vessel was integrated into the existing simulator. In conjunction with this, a maneuvering model based on the actual ship maneuvering data was prepared. This allowed a recreation of the entire shipboard environment for the officers participating in the training.

Once the joystick was installed, the validation of the system was conducted. First the ship model was validated separately by one of the captains to insure that the modeled vessel behaved as the actual ship. Then the joystick was validated by someone with experience with the device as well as the technical representative for the equipment. Also visual and environmental models utilized in the training were validated in a similar manner.

To incorporate this device into our training curriculum, first, lecture modules were presented on the theory and operation of the joystick. Then simple "experiments" were conducted where the students were placed offshore on the simulated vessel to get a feel for how the joystick behaved under various conditions. The exercises were developed so they would incrementally build to eventually include complex maneuvers in authentic and generic ports under adverse environmental conditions. The training evolution would then culminate in an exercise involving a failure of the system and a review of abort and backup procedures. Throughout the course, extensive maneuvers utilizing traditional controls were also conducted.

From our observations of the training it was obvious that the officers' proficiency on the joystick increased dramatically as the week progressed and from their comments, the students' confidence in using the system had increased significantly. I believe, as do the students who have attended these courses, that this is an ideal use of simulation technology. To realize the benefit of the joystick training example one needs only to consider the alternative; onboard experimentation in a real port with a ship full of passengers. I think everyone would agree that this is not the time to try a radically different maneuvering device.

SUMMARY

The joystick is just one example of the right way to introduce a new piece of shipboard automation but this philosophy can translate to other equipment such as ECDIS, IBS, portable Vessel Traffic Systems (VTS), etc. Any of this equipment can be integrated into a simulator so that it may be evaluated or used for training in a controlled environment. Other centers world wide have also integrated joysticks, ECDIS units, voyage management systems (VMS), as well as other specific equipment to conduct research or to meet specific customer requirements with similar results.

Shipping companies must keep in mind that if the people are not trained properly on these automated systems, the majority of them will simply not use the equipment, or even worse, misuse it. This could lead to "automation assisted" casualties as was seen with the introduction of RADAR and ARPA. With adequate structured training programs, however, these automated systems can achieve the desired results of increased safety, reduced workload, and an improved quality of watchkeeping.

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PC-Based Radar Simulators in Coast Guard Approved Courses

Innovative technology has provided a variety of useful tools for the mariner; thereby, making the task of safe navigation much less burdensome. Radio, Radar, and D-GPS are potentially tremendous assets in any pilothouse or ship's bridge.

Unfortunately, simple installation of such equipment does not make vessels any safer to operate. Numerous reviews of marine accident reports suggest that mere installation of equipment is just not enough. However, timely application of knowledge and skills in the proper use of these navigational aids is essential. This was certainly a key factor in the most deadly marine incident on U.S. waters in recent memory.

Well past midnight, on September 22, 1993, a radar-equipped towboat pushing several barges was not where its operator believed it was. The MAUVILLA was lost in the blanketing fog of Big Bayou Canot and headed for the tragic consequences of a chain of events beginning with the allision of a railroad bridge. This incident became the driving force in changes to regulations designed to prevent a repeat of circumstances surrounding the fatal disaster.

More than a decade ago, technology—in the form of marine-radar simulators—was identified as essential to improve marine safety through training, testing, and certifying mariners' competency in radar observation and plotting. Back then the emphasis was on collision avoidance, and the training requirements were directed primarily at masters and mates on vessels of at least 200 gross tons. Radar Schools offered courses based on the MARAD model, as this was the standard adopted by the USCG. Computers running simulation programs provided inputs to actual radar units and displays. Since the implementation of revised regulations as noted above, the scope of Coast Guard approved radar training courses has broadened to also emphasize position determination. Advisory Committee members, public comments, and marine educators provided information useful in the development of NVIC 9-94, the current guidelines for USCG approved radar-observer training courses.

To have radar courses approved today, or to have them remain approved, radar schools must show their curricula complies with the new standards. In addition to dealing with multiple targets (vessels) in collision avoidance, this means incorporating learning objectives on position determination, and using radar simulators with land-masses, coastline, or riverbanks that the students may observe and/or measure. Schools without the requisite simulator capability began searching for upgrades and alternatives. In an effort to keep their costs down, several schools have chosen desk-top, PC-based radar simulation to conduct the required practice and demonstrations of skills. While earlier attempts to offer radar training on desktop devices were unsatisfactory or marginal, this option is now viable due to the significant leaps in power and capability of hardware, as well as the development of software generating the visual elements needed to accomplish the training and testing. Factors leading to the Coast Guard's acceptance of PC-based radar simulators include:

1. A survey of currently available marine-radar units. Reflection plotters appear to have been largely phased-out. They are certainly obsolete for units with ARPA capabilities, or redundant where electronic marking features are used. Consequently, mandating exercises or demonstrations of proficiency in this type of "scope" plotting would be, at best, questionable;

2. The ability of today's PC hardware and software to effectively emulate key marine-radar functions and performance; and,

3. The need to emphasize the focus on developing and demonstrating watchkeeping skills which will positively reduce the likelihood of mishaps, and thereby improve safety.

In addition, the typical deck-license candidate seeking a radar-observer endorsement must have at

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