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# THE USE OF SIMULATION TECHNIQUES IN THE DEVELOPMENT OF NON-TECHNICAL SKILLS FOR MARINE OFFICERS

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## ABSTRACT

Many industries consider the use of simulator techniques as a major contributing factor to the fundamental increase of competency. The Aviation industry is one remarkableexample that motivated the first attempts to manufacture ship bridge simulation. Maritime institutes and centers tended to provide training courses which are based on technical and procedural skills relevant to ships operations. This paper reviews the importance of the use of simulation techniques in the development of the skills of marine officer's onboard ships and the extent of their impact in enhancing the efficiency of masters and navigation officers. In addition to the review the importance of the development of social and cognitive skills training courses in a bid to provide an outline for future research, to look at how the context of training and simulation of social and cognitive skills for officers of ships which affects the successful development of these skills.

**KEYWORDS:** Non-Technical Skills, Ship Simulator, Crew Resource Management

## INTRODUCTION

There is a general consensus among maritime stakeholders that human error is the most dominant contributing factor in causing accidents. It is also widely accepted that human error is a general term which covers a variety of unsafe acts, omissions, behaviors and unsafe conditions or a combination of these.

A recent review of accident database from USA, UK, Canada and Australia confirms that human error continues to be the dominate factor in maritime accidents and reveals that in 70% of recorded incidents. Attributed to human error, failures in non-technical skills such as situation assessment and awareness predominate.(ABS,2004)

Maritime training has addressed the development of technical and procedural skills. Until recently, providing solutions to the problems of developing non-technical skills and the optimal use of crew resources has been neglected in maritime training. Simulator-based training courses were introduced primarily to train the skills of passage planning. This training initiative developed into the Bridge Team Management (BTM) courses that are conducted today on many simulators world-wide and, although not taught directly, they contain some of the elements to be found in Crew Resource Management (CRM) courses developed in other industries, such as aviation.

The 1980s saw the introduction of Engine Room simulators and, towards the end of that decade, cargo operations simulators also became available. However, it is only recently that the combined use of bridge and engine room simulators to provide a total ship simulation environment has been undertaken.

The international maritime organization (IMO) is a specialized agency of the United Nations. The responsibility of the IMO is to create standards to improve the safety of international shipping and prevent marine pollution from ships.

Hence, the IMO determined the fundamental requirements that all masters and watch-keeping officers must be well trained. The training should be taken ashore and before watch- keeping officers are assigned to their tasks on navigational watch in order to be qualified and competent to conduct such task. As a result of that, the safety level on board ships and at sea will increase

The only mandatory requirements in the maritime domain for the development of the non-technical skills of resource management are those of the International Maritime Organization Seafarer's, Training, Certification and Watch keeping Code table A-V/2 of this code specifies the minimum standard of competence in crisis management and human behavior skills for those senior officers who have responsibility for the safety of passengers in emergencies. The competence assessment criteria detailed within the code are not based on specific overt behaviors, but rather on generalized statements of performance outputs, and as such are highly subjective and open to interpretation. Although these standards of competence indicate that IMO recognizes the need for non-technical management skills, Both the standards and their assessment criteria are immature in comparison with the understanding of non-technical skills, and their assessment, within an industry such as civil aviation.

**Simulators Growth and Development**

The use of modern simulation techniques in maritime education can improve safety of operations, this would result in fewer accidents, which in turn will save funds, which could be used to afford the additional training efforts. Additionally if the amount of the increased costs of training is compared to the funds spent presently on damages from accidents.

In carrying out this complex study it was found that:

- 80% of maritime accidents were attributable to human error;
- 65% of these accidents could be attributed to training shortcomings;
- 58% of competencies could be improved by simulator training;
- 45% the above competencies could be improved through simulator training.

It has therefore become investment in marine simulators is not limited to just the largest academies and organizations. In the present time simulator customers represent a wide-ranging mix of different organizations, from public training academies, universities and training centers, to shipping and oil and gas companies (Kongsberg, 2009)

Moreover, it is important to have a look at the current availability of marine simulators in maritime training institutions. It is noticeable that delivery of simulators to developing countries has increased in speed over the last few years. Furthermore, this applies particularly in relation to radar, navigation and engine room simulators (IMO, 1993)

The simulator exercise is essentially of a psycho-motoric nature. "Simulator environment allows cadets to practice skills/competences that he or she would take a longer time to obtain, especially with the trend of short sailing times and shorter port-stays.(Cross,2011)

So that the Arab Academy for Science and Technology and Maritime Transport was established in 1996 with a budget exceeding 65 million dollars, including 12 simulators operating both individually and collectively

## Benefits of Structured Simulation Training

Research and experience over many years indicates that there is a hierarchy of learning which forms the basis of good teaching and successful learning experiences.Learning theory has long established that students learn more effectively if they are actively involved in the learning process (interaction), are given feedback on their progress and have the opportunity to repeat ,practiceand improvement and this is one of competency-based training basics, which requires a clear definition of what should be the learner is able to do upon completion of the learning process.

**Table 1: Learning Hierarchy**

| We Remember: | | Example: |
|---|---|---|
| 10% | of what we read | Reading a textbook |
| 20% | of what we hear | Listening to a lecture |
| 30% | of what we see | Viewing a picture/photograph |
| 50% | of what we hear and see | Watching a video |
| 75% | of what we say | Making a verbal presentation to a group |
| 90% | of what we say and do | Explaining actions during a simulation |

Source: Edmonds D (1994)

Table 1 shows the hierarchy in education and training where the learner remembers 10%, which reads and 20%, which heard from lectures and 30%, which sees 50%, which sees and hears, and this approach is based on the teacher.

We must move away from this approach in maritime education and training to talk and move on to more learning methodology centered on the learner as the learner remember 90% of what he says and does while using simulators.

In addition to the use of simulation systems in maritime education and training puts officers in the circumstances and situations that may not be interviewed during their working lives It is essential that training is a simulation of the event realistic and applicable in real life. Modern marine simulation systems and offers great and advanced technology through a three-dimensional graphics to provide models of real ships in realistic areas The difference between training simulators and training on real ships systems is that the consequences of errors and simulation training using security systems and less expensive, easier and faster in the analysis of the results

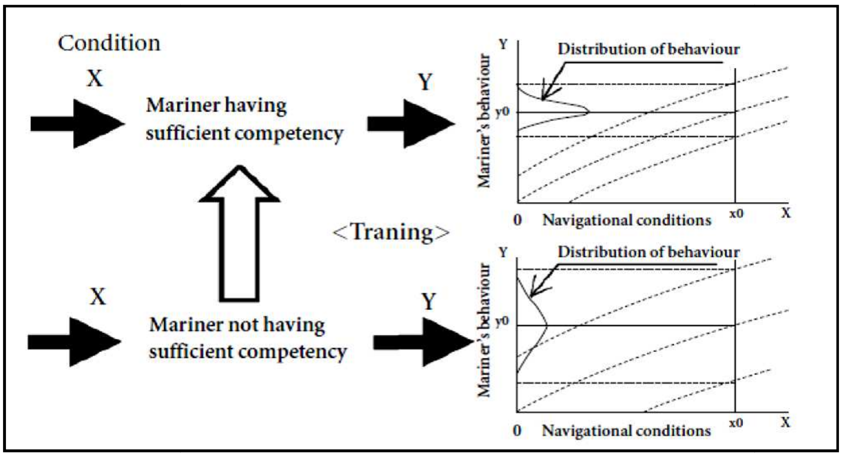


**Figure 1: The Meaning of Training Concerning a Change in a Mariners Competency**

Source: Kobayashi, H. (2005).

Figure 1, shows the importance of training for a seafarer. For instance, in the two right graphs, the "horizontal axis relates to navigational conditions and the vertical axis to seafarers behavior". When seafarers with insufficient competency face the conditions indicated, their behavior shows a wide variation. After training, seafarers with sufficientcompetency are able to concentrate on the required behavior, and the variation of their behavior is much narrower.

**Simulator as Assessment Tool**

Simulators provide a great opportunity to assess the learner strict efficient because they require new thinking from both the learner and the teacher. Traditional examinations can be an effective way as to test the knowledge and understanding of a subject on the part of the candidate. With the introduction of case studies and a requirement to analysis presented evidence this understanding can be tested quite deeply. But any such examination will inevitably struggle to test the competence of a person to conduct a pre-determined task safely and successfully

The rich environment of a full mission simulator enables evidence of competence to be garnered from a wide variety of sources.

The well-developed simulation-based assessment will:

- Gather evidence from the plan of the student
- Observe how the student deploys the equipment at his disposal
- Illustrate how the tasks are communicated to other participants in the exercise
- Identify how delegations of responsibilities are made
- Determine how well the student follows the plan

The compilation of evidence is thus more comprehensive than a traditional assessment. Furthermore, as there is no opportunity for plagiarism, copying or memorizing, the strength of a simulation-based assessment becomes more and more apparent

## STUDY CASE

**Collision and Oil Spill in Traffic Separation Scheme**

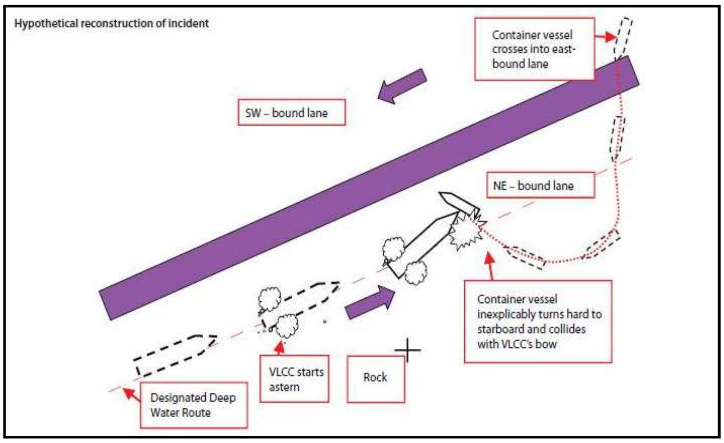


**Figure 2: Collision and Oil Spill in Traffic Separation Scheme**

Source: MARS, (2012)

VLCC was on a loaded voyage and was transiting a busy strait by night, drawing 19.9 meters even keel. During the crucial passage, the bridge was manned by the Master, 3/O and a helmsman. The vessel was on harbourmanoeuvring mode under bridge control, displaying the appropriate signals to indicate her ’constrained by draught’ status. At about 2100 hrs, after reaching her waypoint, the vessel altered course to 070ºT and was proceeding along the designated east-bound deep water route, close to the separation zone of the TSS. A number of vessels were proceeding in both directions within the appropriate lanes. Once on the new heading, the Master observed a container feeder vessel crossing from the west-bound lane into the separation zone and straying into the east-bound deep water route, against the traffic flow. The Master stopped the engine and then went full astern to reduce speed. At the same time the appropriate sound signal under Rule 34 (d) was sounded on the whistle (air horn) to convey doubt as to other vessel’s intentions and illegal man oeuvre.

With VLCC engine still going astern, the rogue vessel crossed about half a mile ahead. Immediately after crossing, she inexplicably began to alter course hard to starboard and turn back towards VLCC. Reacting quickly, VLCC Master, whilst maintaining the full astern propulsion, ordered the rudder hard to port and repeated the Rule 34 (d) sound signal, but the container vessel continued to alter her course to starboard and, on a NW’ly heading, was heading directly for VLCC’s bow. With VLCC still making headway, the container vessel’s port quarter came into contact with VLCC’s bow. The collision resulted in multiple indentations on VLCC’s bow area and a breach in the container vessel’s port bunker tank, resulting in an oil spill.

**The Analysis**

- Violation of COLREGS Rules 5 (Lookout), 8 (Action to avoid collision), 10 (Traffic separation schemes), 17 (Action by stand on-vessel) and 18 (Responsibilities between vessels) by rogue container vessel.
- The available emergency plans onboard ships which tended to be procedures based on single failures, were not applicable, the individuals involved were forced to fall back on their experience to cope with an increasingly complex and unpredictable set of circumstances.
- Awareness of the overall situations by individuals was based on incomplete information in this case both master based on their calculation too much optimism, believe that the conducting is sufficient to avoid collision.
- In this situation it is very difficult for both vessels to the presence of viable communication channel and maintain a shared and agreed awareness of the rapidly changing situation.

**Philosophical Underpinnings**

As the above case study illustrates, the majority of accidents and incidents are not caused by technical problems but by the failure of the crew to respond appropriately to the situation. However, while other safety critical industries and the military have heeded this message and have been training and assessing resource management skills as a way of ensuring that errors are effectively detected and managed. The maritime industry continues to lag behind.

At the Maritime Centre in War sash, courses are now being developed that go beyond STCW 95. One such course, the Crew Resource Management (CRM) course, is almost entirely concerned with teaching human behavioral or non-technical aspects of ship operations. Technical aspects of ship operation, such as ship navigation or power generation, are not covered as separate items. Rather, the course curriculum is devoted to social and cognitive aspects of seafarers’ performance, i.e. it is devoted to those skills thought to be important in assisting in the detection and management of errors. A further novel approach of the War sash course is the incorporation of human behavior research findings in learnt what he needed to learn, and can apply the skills practiced at the training institution, onboard ship. The purchasers' wish is to be assured that they have spent company money to best effect.

Lecturers, on the other hand, are acutely aware that to achieve attitude or behavior change in days is an inordinately difficult task, especially when presented with a class of officers of differing rank, experience, and nationality. Unfortunately, the trap into which lecturers fall is to equate value for money with value added. Rather than adopting a teaching strategy that focuses on how students learn, they adopt a strategy that focuses on what the teacher teaches (Biggs, 2003). The result is that the expert lecturer transmits as much of his expertise as possible in the time given (value for money) rather than changing the attitude or behavior of their class (value added). The philosophy underpinning the crew resource management course delivered at War sash Maritime Centre is student centered as opposed to lecturer centered, and thus represents a course that seeks to add value to the participating officers through attitude, behavior, and cognitive change. The instructional system or process employed at War sash to bring about these changes draws on theories of learning.

**Non-Technical Skills Onboard Ships**

Unfortunately there are no clear guidelines for identifying non-technical skills on board and how they should be assessed in maritime industry. The author designed a simple questionnaire to identify non-technical skills from the perspective of the masters of commercial vessels operating on the high seas. Has been completed questionnaire during several interviews was to inform participants on the importance of maritime safety and the role of the ISM Code in the creation of maritime safety culture. And it raised many interesting points during the interviews, but emphasis was placed on the following technical skills is and its impact on the completion of tasks.

The following non-technical skills were strongly emphasized on as the most influential factors in successful completion of the task;

- Leadership And Management
- Time management, Planning and preparing, Ability to use authority
- Team work and Cooperation
- Inter-team communication, Ability to criticize, Ability to receive criticism, interpersonal communication, listening, team work, transferring information Supporting others in critical situations
- Problem Solving/ Decision Making
- Ability to recognize priorities, Ability to carry out multi-task, problem solving ability
- Situation Monitoring

Ability to look at the task from different angles, Ability to identify potential hazards, Envisage and Conception, Anticipation of future problems

**The Most Effective Ways of Training Non-Technical Skills**

In the year 2000, the Maritime Coastguard Agency (MCA), following a recommendation of the Marine Accident Investigation Branch (MAIB) in response to the loss of the "Green Lily", awarded a project to a research team at Warsash

Maritime Centre. The remit of the project was to investigate the potential use of simulators for training in the handling crises and escalating emergencies. This project enabled the researchers to review current concepts and models in the field of resource and crisis management across a range of safety critical industries and to conduct a survey of expert opinion on the optimal training and assessment regimes (Barnett et al 2002).

In order to ascertain the optimal types of simulation to provide training and assessment of non-technical skills, the Warsash research team used a panel of 15 experts drawn from marine simulation resources as well as researchers and practitioners from other similar safety critical industries. Within this project, the Policy Delphi Method was used . The Policy Delphi process is a form of policy analysis that provides a decision maker with the strongest arguments on each side of the issue. A range of future implementation scenarios were proposed as training policies that could meet the perceived training requirements relating to the exercising of resource management skills. These policies were presented to the panel of experts. A subsequent workshop involving some of the panel experts was also used to confirm and develop their responses.

## CONCLUSIONS AND RECOMMENDATIONS

The analysis of maritime accidents over the years has revealed shortcomings in the ability of operators to manage both resources and crises. CRM training has been seen increasingly as a fundamental part of the human error management philosophy. However there is still much unknown about human behavior in response to unexpected events or unplanned. Training and development of management skills of the team is the way they have to prepare personnel to manage such events. It is highly recommended that all maritime colleges must establish new advanced educational strategy to improve the learning of their learners, whether the courses are simulator based or not. Learner need to be given opportunities to be active discoverers rather than passive recipients of knowledge and thus courses dominated by one-way lecturer transmission are unlikely to be effective. Learner also need to be able to interact in a social environment, one in which the lecturer gradually reduces control and one in which student brave efforts to develop understanding are encouraged. learners also need to be guided in the interpretation of experiences, whether in classroom or simulator. Reflection on experience is a process that has powerful effect on adults learning.

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