

Applications of Simulation Technology - Pitfalls and Challenges

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ABSTRACT: Simulator based training has its own unique features and problems associated with it. There is a need to discuss these issues in order to understand the real meaning of simulator based training and to handle it effectively. Like other fields of training, use of simulation in the maritime industry is owing to the multiple factors covering technological, financial and training needs of the time. When properly used, supported by well trained and experienced instructors, simulator training, through its risk free environment, can contribute to a reduction in accidents and improve capability and efficiency, by providing trainees with the necessary experience and self confidence to carry out their roles, functions and tasks.

1 INTRODUCTION

The When Confucius said in 451 B. C. that "What I hear, I forget; What I see, I remember; and What I do, I understand" it may not be a simulator in his mind, but surely he was referring and emphasizing the significance of practical experiences vis a vis the spoken words.

Simulator based training has its own unique features and problems associated with it. There is a need to discuss these issues in order to understand the real meaning of simulator based training and to handle it effectively. Like other fields of training, use of simulation in the maritime industry is owing to the multiple factors covering technological, financial and training needs of the time.

Interactive training simulators can be developed which can allow several crew members to practice operating the equipment and performing the procedures together, as demanded by the working life style onboard ships. New technological developments have made simulation very cost-

effective and attractive not only for training purposes but also for research purposes.

When properly used, supported by well trained and experienced instructors, simulator training, through its risk free environment, can contribute to a reduction in accidents and improve capability and efficiency, by providing trainees with the necessary experience and self confidence to carry out their roles, functions and tasks.

It may be rightly emphasized time and again that simulator based training is the concept which is more and more in practice due available technologies at low cost; we need to know the various dynamics of this form of training and make it effective by proper use of the technologies. After all, Aristotle has rightly said that "What we have to learn to do, we learn by doing."

2 SIMULATION TECHNOLOGY

2.1 Major factors for simulation usages

Like other fields of training, use of simulation for maritime applications is owing to the multiple factors covering technological, financial and training needs of the time. Some of these factors are as discussed in the following lines; Owing to technological advancements, simulation technology is available for multiple types of military operations at a very cost-effective price.

- Simulators are coming closer to the real thing; in fact, whole of the system fitted onboard can also be installed as simulator in a purpose built scenario.
- One can plan a training schedule as per his convenience and simulator will be available for use.
- One can run and speed up his game on simulator as per training requirements without worrying about related costs or time constraints.
- Training scenarios beyond safety limits are possible without jeopardizing the life and property of any kind.
- Conditions and environment in a simulator can be repeated again and again to improve the learning outcome of training; unlike the real scenarios where all situations are new ones and no repetition is available.
- One can choose his area of operation for maximum training value and increasing confidence and morale of the trainees.
- Performance on simulators can be recorded and played back to the trainees for carrying out analysis, providing feedback and pointing out mistakes done during the exercise.
- One can jump over the exercise or run the exercise at accelerated pace as and when demanded by training requirements and time constraints.
- Conditions in simulators are known and repeatable so that performance in these conditions can be graded and assessed with uniformity.
- One can develop situations onboard simulators which are much more complex and grave when compared with real operations and are difficult to create.

In order to find out what trainees feel about simulators when compared with a real ship environment, seafarers were asked during survey a question as under;

What were your feelings when you for the first time acted as operator / trainee on simulator?

- 1 It gave a feeling of a real ship environment.
- 2 It was just a good effort to mimic the real ship.
- 3 It was too artificial when compared with real ship.

In response to this question, majority of the respondents said, as shown in Figure 2.1, that a simulator was neither like a real ship experience nor it was too artificial to be useless. So a simulator instructor has well enough equipment to start with; but fact remains that finally it is the instructor who has to bring it as close to real experiences as possible through his handling of both the equipment and the trainees.

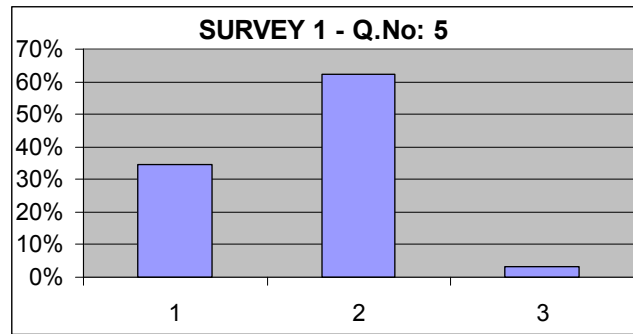


Figure 2.1. Simulator Experience vs. Ship Environment

Much work has already been done on the advantages and disadvantages on simulator based training and its comparative value vis a vis real time experiences. Now, the only discussion is when to have and how to have the simulator based training for the seafarers for better, efficient and speedy operational training.

2.2 Military applications of simulation

When discussing the military applications of simulation technology, we need to examine how technological advancements are affecting the future trends in simulator manufacturing and how they can best be utilized for optimum training value. Furthermore we need to study the increasing importance of instructors and controllers due to induction of simulators in the field training with multiple variables and varying situations.

Simulator training had obvious advantages of being economical, safe and redundant. But it had its own implications as well. However perfect a simulator may be with respect to design and manufacturing process, it was still far away from real equipment and scenarios. Instructor became more and more important. He is actually responsible to connect up the simulator experience with real ship operations through his visualization and must not let the trainees get into a discourse or fall into a game mood. Simulators became more and more common around the globe and they were taken as symbol of quality training being imparted by an organisation.

Simulation usage was encouraged in the aviation industry due high cost of fuel and safety risk involved in real time training. Early World War II was tough for military aircraft flying due short supply of training aircrafts and high demand of proficient pilots [1]. This led to shift of pilot training on simulators instead of real aircrafts. This was also the time of high cost of simulators. Now technological advancements have reduced the manufacturing cost of the simulators and they can be used for multiple simulation requirements while still being cost effective.

Apart from financial benefits, simulation also improves the safety of operations. Flight safety gains significantly from simulation techniques. NASA maintains safety standards in manned space adventures through simulator based training and no alternative is available to simulation training. The nuclear power generation industry also makes extensive use of simulation for training and

qualification programs of reactor operators to ensure safety and competency.

Working onboard naval warships is becoming more and more hazardous due usage of multiple types of equipment and ammunition in limited time and space matrix. This puts high burden on the quality of training and need for simulator based training is rising continuously [2]. Virtual proto types can improve naval safety by allowing personnel to gain experience of naval equipment and procedures before they are exposed to actual equipment in potentially hazardous conditions.

2.3 Technological advancements

New technological developments have made simulation very cost-effective and attractive not only for training purposes but also for research purposes. Innovative simulation systems are purposefully designed to carry out research on specific problems. For example, an autopilot system was designed and developed for fast- time simulation in confined water ways by University of Ghent in Belgium, specifically meant for research purposes [3].

It was the increasing level of automation which made the new demands on education and training [4]. Many of the training processes became out-dated due main reason of paper based qualification. Trainee was required to go through class room instructions and then sit in some written examination. Fact remains that changes demanded new stress on competency and the way it can be demonstrated by the trainees. Simulators can be the best source to demonstrate the competency of a military personnel individually as well as when forming part of a team working onboard ship.

It is widely acknowledged that majority of all accidents or casualties at sea are caused by the human element. This shows high demand on part of the training establishment to ensure competency of the individuals. There can be many reasons for justifying the use of simulation for training. Prof Peter Muirhead while discussing the simulator training philosophy says that the inexperienced individual is likely to make errors of judgment early in any field training [5]. The consequences of such errors could be costly and catastrophic.

On simulator, the individual can make multiple errors, and receive extrinsic feedback to assist in improved performance in real scenarios. Rapid repetition of difficult situations allows a review of tactics until a satisfactory conclusion is reached. Some tasks cannot be experienced at the field even when putting in maximum efforts and taking in all possible risks. Emergency procedures, maneuvering in different terrains or geographical locations, are readily available only on the simulator.

When properly used, supported by well trained and experienced instructors, simulator training, through its risk free environment, can contribute to a reduction in accidents at the field and improve capability and efficiency, by providing trainees with the necessary experience and self confidence to carry out their onboard roles, functions and tasks.

Advent of the computers, integrated electronic navigation systems, monitoring equipment, data collection and presentation, and satellite communication have produced a change in the traditional role of the seafarers in field operations, machinery control and situational appreciation. Fast developments in the field and reduced manning standards have put extra burden on military personnel to have appropriate competencies. Only then they can ensure that assigned task is completed with safety and efficiency.

Following question was raised to the METICs during the Survey on Simulator Instructor;

What is the major problem being faced by the instructors with respect to the simulator trainees?

- 1 They feel difficulty to overcome the simulation artificiality.
- 2 They get into a mood of playing game on simulators.
- 3 They just pass the simulator time without being concerned.

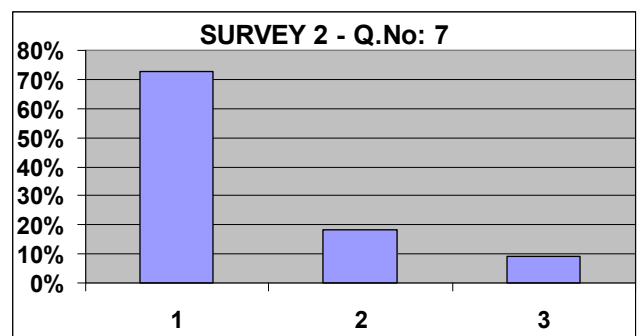


Figure 2.2. Major Problems Faced By Simulator Instructors

Majority of the respondents indicated, as given in Figure 2.1, that they feel difficulty to overcome the simulation artificiality. So, one of the major disadvantages of the simulator based training is the artificiality of the equipment involved. It's the psychological environment created by the instructor which can reduce the negative effects of the in-built artificiality of the simulator based training.

Changes in design, size and speed of the maritime hardware also puts new demands on the training and education of the personnel. In parrallel with political and security implications, economic and environmental consequences of a casualty involving any of the large scale disaster also demand a high level of personnel training to deal effectively with a situation.

2.4 Changing training requirements

Personnel reduction and the trend of achieving maximum goals with minimum personnel employed may prevent the availability of additional trained manpower for special scenarios. An array of inter-connected equipment and information output devices require a team-approach to permit rapid and effective responses to difficult circumstances. In order to deal effectively with the changing operational scene, new approaches are needed in

training. Whole of the training can not be carried out in the real scenarios and developed situations.

Handling of the new generation of machinery and equipment in all environments and situations is an important facet in the competence of the present day seafarers. Many of these required skills can be acquired and evaluated on simulation technology without risk to equipment or danger to life. Confidence in their use and application can only come through experience and not just via any textbook or written material. Multi-tasking simulators for example provide both the situations and conditions to expose the individual to multiple experiences.

Simulator training can be used to improve the level of proficiency in those tasks or aspects in which real experience proves to be inefficient or deficient. Simulators cannot replace the real experiences, it being no substitute for the depth of skills made possible through the operations in the real environment over a period of time. This cost in time however is relevant, and the simulator can provide the opportunity for the individual to improve his skills in certain desired and required tasks over a very short period of time.

3 MAJOR FEATURES OF SIMULATOR BASED TRAINING

3.1 Fidelity vs. Validity

Fidelity and validity are the two features which depend on each other in simulation. There is a direct relationship between fidelity and validity. Fidelity, the inclusion of the real world elements, contributes to validity. The omission of real world elements may make the valid system performance on the simulator impossible. It is not appropriate to consider the provision of high fidelity a substitute for validation of the system. However, there is generally more confidence in a high-fidelity system than a low-fidelity one.

Fidelity adds to the validity of simulation; in the past it may have added to the cost considerably. This relationship has changed due to present day micro-processor developments. Therefore, it is necessary to examine exactly what fidelity is adding to the effectiveness of simulation.

Validation is an ongoing process and therefore when components of a system are changed, they should be validated to insure the fidelity level is consistent. This is usually done as part of acceptance testing and trials of the simulator.

3.2 Reliability vs. Uniformity

Reliability of simulator based training means that instructor was able to impart all the performance standards to the trainees as he planned in the exercise or were part of the training objectives. Uniformity of the simulator based training means that when same simulator exercise is run for multiple trainees at different times, it has same training value with respect to basic learning out comes.

An exercise on simulator can be very good, effective and reliable but then the problem of uniformity is required to be addressed. Best exercise is the one which has both, reliability and uniformity in parallel.

3.3 Simulators vs. Field Training

Simulator based training is steadily replacing the in-service or field training of military personnel. Over the time, commands also gives weightage to the training conducted at a simulator in parallel with experience of field training. Over the time, simulator based training has started having more face value and weightage. Training needs to have validity and reliability both in parallel.

Following question was posed to the seafarers during first survey on simulators.

What were your experiences when you practically worked on the system after simulator training?

- 1 You felt much more confident on the system than before.
- 2 Training made no difference in your working efficiency.
- 3 Training adversely affected your performance on the system.

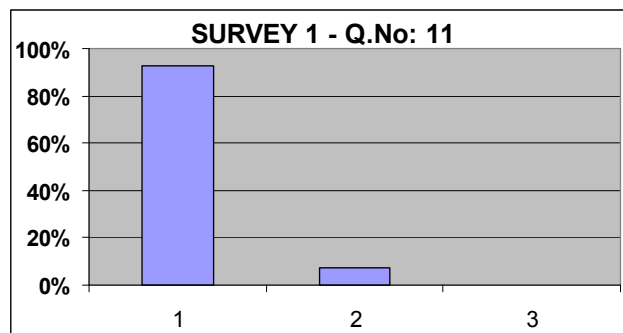


Figure 2.3. Effectiveness of Simulator Training

Responses to our survey, as given in Figure 2.2, over-vehemently supported the use of simulators for training purposes by highlighting that the seafarers always felt much more confident on the real equipment after the training session on simulators. It shows the effectiveness of the simulators.

Now simulators can simulate a diverse range of equipment's types, scenarios and situations which in actual life may be rare to occur. This increases the validity of the simulator training vis a vis in-service experiences. Also with regards to reliability, simulation can be very effective due positive control and training environment in the training institutes; whereas field experience may have difficulty in controlling training conditions and administrative procedures.

4 DESIGN PROBLEMS OF SIMULATOR BASED EXERCISES

4.1 Objectives of the exercise

How to design an exercise for running on simulator will be governed by the objectives of the exercise. Who are the trainees, what their qualification is and what are the competencies they need to learn. Simulator instructor will be required to brain storm on deciding the objectives of the exercise when running any course on simulator. Deciding objectives is very important as it is the foundation stone on which all the variables will be decided and objectives will govern the successive stages one after the other.

4.2 Monitoring by the Instructor

It is very important that simulator has the features of a comprehensive monitoring system in order to observe the trainees properly from the Instructor Control Station. Instructor should have multiple ears and eyes and easy control over whole of the working area so that he can perform in a peaceful manner. This monitoring system should also include audible microphones, well positioned on the exercise area to hear conversation of all the members of the simulation exercise.

In addition, there should be enough TV cameras on the bridge and monitors at the control station to observe the working of the trainees on various duty places in whole of the exercise area. A monitor should be in control room to observe how the various equipments are being operated by the trainees and what all information is available to them through these equipments.

A bird's eye view of the exercise area at different ranges should be available for control, and future reference and debriefing. Finally, recording of whole exercise including audio / video should be available for re-running in the de-briefing of the exercise and analysis. These will also help in subsequently re-designing and improving the exercise for future running for same level or composition of the trainees.

4.3 Briefing before Session

A briefing has to be conducted before commencement of the exercise by the instructor for the trainees. It is advisable to have briefing in the simulator room itself when explaining various parts and equipments. When more than one instructor / staff is involved, all instructors should be present during the briefing session, thereby giving chance to the trainees to raise questions if any and also to recognise and develop mutual relationship with instructors / staff that will be conducive in achieving the exercise objectives.

Briefing should include all the set conditions of the exercise and exercise objectives; number of trainees involved, trainee leader if any or the team composition, instructors involved and their respective tasks, time duration, break time and duration in the exercise.

4.4 Exercise Conditions

Before commencing the active training session on simulator, it is recommended that exercise design should include all the conditions to be set on simulator at start time. This will increase and ensure the validity of the training session. Conditions include listing of all the equipment that will be used during the exercise and also the equipment which is not fitted or not available during the session.

5 FEEDBACK ON SIMULATORS

It is well recognised fact now that simulator based training has the potential of providing knowledge which other wise could only be gained through years of real world experiences. Realization of this potential, however, depends upon the ability of simulator training program to take into account the special cognitive needs of the trainees and ability of the instructor to properly provide the feedback to the trainees.

Feedback to the trainee on simulator regarding standard of his performance is very important for maintaining interest, keeping morale and improving performance of the trainee [6]. With regards to effectiveness of the feedback provided to the trainees, Stephen said that two factors are important to be considered while providing feedback;

- 1 Timing of the feedback is very important. Some errors can change the subsequent run of the exercise and need to be corrected immediately. While, there are errors which take time to produce results and instructor will be more prudent if he waits and delays the feedback. Delayed feedback also helps the trainees with time to think and analyse their actions and consequences.
- 2 Redundancy is another factor influencing the performance feedback's effectiveness. Studies indicate that repetition of same feedback may reduce interest and motivation of the trainees.

While discussing the process of training on simulators, Feedback provided to the trainees was divided by Stephen into three sub-categories;

- 1 Intrinsic feedback where trainee will come to know appropriateness of his actions through consequences achieved. This is the simplest form of the feedback and is always present in simulator based training. Still, it is duty of the instructor to ensure trainee has the perception of high standards to compare his performance.
- 2 Augmented feedback can be provided to the trainees through providing them an overview of their whole of the exercise area. This bird's eye view will help them in understanding their successive inter-related actions and their results, and this will even improve the intrinsic feedback's quality.
- 3 Supplemental feedback is highest form of feedback that can be and must be provided to the trainee. When trainee is on task, his mind is pre-occupied with so much of information that he can come under stress and unable to grasp altogether new idea or approach. When he is over from exercise situation, then providing him with

complete picture of the exercise will be of great value and trainee's mind will be free for self criticism and true analysis of the actions taken during the simulator session.

6 CONCLUSIONS

Simulator Based Training has its own unique features and problems associated with it. We need to know the various dynamics of this form of training and make it effective by proper use of the technologies. Like other fields of training, use of simulation for military applications is owing to the multiple factors covering technological, financial and training needs of the time. Simulators are coming closer to the real thing; in fact, whole of the system fitted in the field can also be installed as simulator in a purpose built scenario.

Simulation has the concepts like fidelity, validity, reliability, and uniformity and we need to understand these concepts being simulator instructor. Designing and developing an exercise to be run on simulators is a complex process and involves many important features. Feedback to the trainee on simulator regarding standard of his performance is very important for maintaining interest, keeping morale and improving performance of the trainee.

There is always a particular relationship between an instructor and his trainee. Traditionally, a teacher has an overwhelming influence and effect on how the training is conducted. There were times when instructional techniques meant effective use of training aids and class room environment. Simulator instructor has different role to play than a normal instructor. Good simulator instructor means good trainer and thus simulator instructor has to inculcate in himself all the qualities of a good trainer.

7 RECOMMENDATIONS

Being cognizant of the modern trends in education and training, various military organisations are investing heavily in the simulation technologies and systems. This trend is encouraging and will pay the

dividend in due course of time. We as industry leaders and training professionals need to understand that;

- 1 Simulation technology as stand-alone and integrated-system has its own usages and requirements. We need to understand these usages and requirements while understanding that none can replace the other, though they augment each other.
- 2 While simulation is coming much closer to the real field experiences, it is the instructor who will be instrumental in ensuring this closeness of the two experiences.
- 3 Training and certification of the simulator instructor is the area requiring the much attention of the training institute and the maritime administration in the process of simulation based training.
- 4 Capacity building of both the instructor and the trainees is a continuous process which needs to be audited and ensured through a well structured training and certification system in place at the training institute and command.

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