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An investigation into the potential use of PC based simulator tools in the MET programs of a developing country

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AN INVESTIGATION INTO THE POTENTIAL USE OF PC BASED SIMULATOR TOOLS IN THE MET PROGRAMS OF A DEVELOPING COUNTRY

By

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred to me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: **An investigation into the potential use of PC based simulator tools in the MET programs of a developing country**

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The improvement of operational capabilities of the individual mariner can be enhanced by the use of PC based simulator tools. This research attempts to examine the current and future development of PC based simulator products and investigate how such tools can be used effectively in MET institutions.

The basic structure of a PC based simulator is first discussed. An introduction to fundamentals of PC based simulation and the elements that contribute to the operation of the modern PC based simulator is provided. The benefits of PC based simulation as an open learning tool are highlighted. A brief evaluation of potentially useful PC based simulators in the light of new international standards is conducted. Considerations for software approaches and current PC based simulator software products are also discussed.

The impact of the revised STCW Convention on MET programs with reference to the use of new technology is considered. The staff training and role of instructors are taken into account. The qualifications of instructors and assessors are discussed. This paper also investigates the selected simulation training methodology in MET establishments. A brief description of other types of simulation is made.

This paper makes recommendations for the introduction of PC based technology into the Myanmar MET system and that of developing countries.

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LIST OF ABBREVIATIONS

AMU	Audio Multiplexer Unit
ARPA	Automatic Radar Plotting Aids
BFSSL	Burma Five Star Shipping Line
CAORF	Computer Aided Operation Research Facility
CGI	Computer Generated Imagery
DOS	Disk Operating System
EGA	Enhanced Graphics Adapter
FESMA	Far Eastern State Marine Academy
GMDSS	Global Maritime Distress and Safety System
IALA	International Association of Lighthouse Authorities
IMO	International Maritime Organization
IMT	Institute of Marine Technology
kb	Kilobyte
MET	Maritime Education and Training
MLPC	Master Level Proficiency Course
MMTS	Mercantile Marine Training School
OOW	Officer Of the Watch
PC	Personal Computer
RAM	Random Access Memory
RPM	Revolution Per Minute
STCW	Seafarer's Training, Certification and Watchkeeping
UPS	Uninterrupted Power Supply
USCG	United State Coast Guard
USMMA	United State Merchant Marine Academy
VGA	Video Graphics Array
VTS	Vessel Traffic Services

CHAPTER 1

Introduction

1.1 The existing MET system in Myanmar and currently training practices

The Institute of Marine Technology (IMT) was founded on October 1, 1971 under the auspices of the Ministry of Transport and Communication.

The faculty of the IMT is made up of the Department of Nautical Science, the Department of Marine Engineering , and the Electronics Department which is under the Nautical Department.

The courses range from cadets training , and rating training to master (foreign-going) refresher course in line with the national needs. The institute is designed to enable trainees to comprehend broad operational shipboard techniques such as watch-keeping, navigation, ship manoeuvering and handling, operation and upkeep of engines, first-aid treatment and so forth. The IMT is also designed to enable ratings trainees to learn the basic techniques to be prospective seafarers.

The courses currently offered by the IMT can be categorized as follows:

a) Refresher Courses;
b) Short Courses (I.M.O Model Courses);
c) Seaman (Rating) Courses;
d) Cadet Course.
(see Appendix A)

1.1.1 Simulators units at IMT

Simulation units for ARPA, engine room control simulation units, computerization and stability simulation units with wave generating tank have been installed at the IMT since 1989. A planetarium is accessible for those attending as cadets at the IMT.

The radar simulator includes two "own ships" expandable to four and separate helm and engine controls, capable of simulating 20 targets. In an instructor room, a color graphic X/Y plotter, echoes generating panel and coastline generator are installed. A color video display in the instructor room can be switched over to any own ship whenever required. The type of the radar is FURUNO and the software is run on the Hewlett Packard computer-9000 series. Communications between instructor's station and trainees' room are available. All actions taken by the trainees during an exercise can be recorded for later assessment.

The Electronic navigation aids-simulator is composed of an echo-sounder, an automatic direction-finder, a loran receiver, an omega receiver, a satellite navigator, a Decca receiver, and two video plotters. This simulator is separately run by Hewlett Packard computer-9000 series from radar simulator.

In the stability room, two loadmaster-computers have been installed. Software packages designed to assist in routine loading and discharging of cargoes for container ship model, bulk carrier model, tanker model, and general cargo model can be run on these computers. New ship models can be developed by Formula Translator language (FOTRAN) programming language. So far, no new ship model has been developed.

There are thirty computers (IBM compatible, 486 DX/SX) and 11 printers with four UPS in the computer room and these computers are being used only for word processing, accounting, database and spreadsheet calculations.

The wave generating room and engine room simulation control units are under the control of the engine department.

1.2 Background and objectives

The first MET institution in Myanmar was founded under the Ministry of Education and Health in January, 1963. This institution was established primarily to provide education and training for the Burma Five Star Shipping Line (BFSSL) and no ratings had been trained as seafarers at that point. This MET institution was named as the Mercantile Marine Training School (MMTS) and was combined with the Naval Base Training school. Initially nautical and engineering cadet courses were offered at MMTS. Training, examining and certification systems were influenced by the British system. The institution was reluctant to develop its own system so as to meet the quality and required standards.

With the development of Myanmar's maritime industries, there is an increase in demand for qualified cadets as well as prospective seafarers. Accordingly, the

MMTS was moved beside Myanmar Shipyard and reorganized as the Institute of Marine Technology under the Ministry of Transport and Communication.

The government acted decisively to review maritime activities when the profound impacts on training, recruitment and operational handling on board ships caused by the rapid advancements and new regulations adopted by IMO in maritime industries were understood. As a result, the national seminar of the MET .and examination system was held in 1992. The Significant modifications have been executed in order to meet IMO requirements and guidelines.

The major tasks and objectives of the IMT are as follows, to:

- educate students to become certificated officers of international standards in accordance with IMO regulations
- train seafarers to become internationally recognized marine personnel in order that they can be employed onboard vessels owned by national and foreign shipping companies

1.3 Availability of resources

A "free education" system has existed in the Union of Myanmar for many years. The IMT is owned and funded by the Government. It is, however, also possible to obtain funds from the private manning agents and foreign aids.

The IMT often needs modern teaching aids, and adequate training equipment and qualified lecturers. Accordingly, the IMT has to seek these requirements through other ministries such as the Ministry of Education, the Ministry of Health and theMinistry of Agriculture.

1.4 Research Methodology

Once the topic of this paper was selected, the author drew the outline research plan and submitted it to the Course Professor. After the topic had been approved, library research was done by collecting relevant data from the library of the World Maritime University. Having discovered the materials which might be useful, the author inspected it more strictly to observe whether it would be of value. An indication of how up-to-date the materials was, came from checking and noting the date of publication. Further sources of information to follow up were indicated by the bibliography. Observations and discussion notes were carried out during field trips and various maritime institutions. Other appropriate information was obtained from some manufacturers. Analyzing and evaluation of the current products available for the project have been performed in the computer laboratory of the World Maritime University. On-going guidance and advice were provided by the supervisor.

Finally, the information and data acquired were examined carefully and ideas synthesized to reach conclusions and recommendations.

CHAPTER 2

THE BASIC STRUCTURE OF PC BASED SIMULATION

It may be considered that simulation is composed of a model of the system to be simulated, a mechanism through which the model is utilized and evaluated, an application regime for which the simulation is intended and a curriculum which offers a concise view of the components of education. A number of interactions among these components are involved with any training and research. It is generally accepted that variations in the actual number of interactions and their complexity depend on the applications.

The basic model used with coexisting ship simulators is formed by a mathematical representation of a vessel and its hydro- and aero-dynamic responses. The mathematical description of the behaviour of a system in terms of a number of equations is the most usual form of a model discovered in PC based simulation. A well-designed model should include the mathematical model of the ship motion dynamics , autopilot algorithms, fairways, port, and underwater topography. Also ship control arrangements, rudders, thruster, pitch, RPM, wind effects, including lee from building, bank and quay effects, tow and push forces from tugs, autopilot-controlled track-keeping, current and shallow water effects , mooring line loads and winch power. The simulator would either be motionless or imprecise due to the lack of an adequate or representative model.

Simulation may provide an incorrect solution or false information if the simulation is incomplete or the parameters of the simulation are incorrect. Since the simulation will hardly ever be a perfect imitation of reality, the application needs to be scrutinised and the methodology of technique is also important.

The consequence of appropriate application, insufficient facilities and inadequate model should be taken into account if utilising PC based simulator tools. According to Elmaghraby (1968), five common uses of models and simulations have been listed as follow:

- as an aid to thought
- as an aid to communication
- for purposes of training and instruction
- as a tool for prediction
- as an aid to experimentation

(Elmaghraby, 1968)

The application for which the simulation is designed is the working regime. A variety of applications can be found. In an application regime, training objectives, training methodology, standards for equipment performance and standards for instructor competence need to be scrutinised because the simulation will hardly ever be a perfect imitation of reality.

Training is what it suggests it is, a method whereby knowledge and/or skills can be transferred from the person who already has them to the person(s) requiring them. The training function is purely to transfer knowledge and skills; assessment is designed to show how effective any particular person is in the application of his knowledge and skills under carefully simulated workplace conditions. Simulation, as a product of modern technology, is a powerful tool that enables not only the transfer of knowledge and skills through training, but also provides an effective method of assessing competence.

Accepted curriculum development practice must be followed by the elaboration of a curriculum for ship simulator training. The process in curriculum development for a ship simulator is the same as the development method of any other field of education. The curriculum impacts on the simulator and the trainee. Learning materials which are intended to prepare the trainee with the background information required for success must definitely state the practical and feasible learning objectives. Learning objectives, learning materials and evaluation tools should be contained in the accepted curriculum.

Well-designed simulation training provides the facilities which allow trainees to develop their own learning strategies and make the best use of their individual abilities and talents.

2.1 The training structure

The examination systems of countries are different in many ways. The result of variations in different examination systems is to cause a wide variety in the education training schemes offered. Differences were noted in the length of training and in the number of contact hours with trainees in the training groups. The way to solve training and business problems is by using modern technology. The use of the micro-computer to standardise the examination of deck officers is an existing possibility and the use of computer-based training could be the best approach.

The use of PC based simulators can replace a substantial amount of training time on board. However, it is now generally recognised that actual training time in the simulator will take at least as long as it would on board.

In most cases, motivation is a key element in performing effective simulator training. Positive attitudes towards simulation must be held by instructors and communicated to the trainees.

2.2 Training objectives

Most training objectives can be summarised as:

- to promote the safety of ships and the protection of the marine environment
- to contribute to the development of the world maritime industry

Specific criteria detailing the standards of knowledge, understanding and proficiency to be achieved by candidates for certification in each component of qualification are contained in the revised STCW Convention and the criteria for assessing standards of competence are explicitly designated. To improve efficiency and safety on board is the purpose of training. In onboard operations, MET requires a formalised method of furnishing knowledge, skills and competence which is associated with navigation or trading on the sea. An integral part of education appears to be training. In the final generalisation, developing the skills in a profession or occupation is achieved by practical training. For many years, MET has been closely involved in the training of seafarers. Much attention has been placed on the preparation of ship operators. According to the individual course frame, the training objectives for the simulation training course will diversify.

Now that ships have been purpose built for carriage of a specific type of cargo or engaged in a special trade, training needs have become more specific than general.The construction of a large specialised ship which needs to be operated by highly qualified and specialist officers and ratings has been simplified by advanced technology. The impact of reducing the decision making roles of shipmasters, chief engineers and officers has been brought about due to computers and the development of electronic data interchange. The method by which ships are operated has been in addition changed by automation. The possibility of engine control from the bridge is now feasible.

Traditionally, the "rules of the road" have been learnt through studying text books by students in class room. At sea, apprentices have to observe the actions of a qualified officer of the watch. Now, the interactive nature of PC based simulator tools can be available and these tools have been prepared to develop and to improve student's knowledge and reactions to "rules of the road" situations by providing a realistic decision-making environment.

It has been clearly stated in the revised STCW 1978 Convention that the aims and objectives of simulator-based training are to be defined within an overall training programme and that the selection of specific training objectives and tasks are to be related as closely as possible to shipboard tasks and practices.

2.3 Basic concept of simulation

A correctly designed and equipped training simulator offers the following benefits over traditional training.

- Reduced training time as a PC based simulator tool is a form of self-pace learning, the trainees are allowed to continue at the rate which suits them. Traditional training is a form of group-pace learning and the whole class is controlled by the instructor.
- Increased efficiency and availability, since factors such as adverse weather conditions, space limitations or training ship availability will not interfere with training.
- Lower overall training costs
- The facility to practise situations which for reasons of expense, safety and practicability cannot be rehearsed in the real world.
- Consistent quality of training might be achieved by using well designed PC based simulator tools. Although the minimum training requirements are always the same in traditional training, the lesson quality tends to vary from one instructor to another, and even from class to class with the same instructor. A topic can be taught out of sequence and the quality of training might also tend to vary from class to class because the instructors do not always follow lesson plan.
- Increase safety whilst training, coupled with the ability to control the level of task demand applied during training.
- Adapt to meet a variety of training requirements because most PC based simulator tools are designed as a series of modules. As a result, the specific needs of the individual can be matched to training, flexible training can be achieved and experienced trainees do not need to waste time on material they have already covered.
- Availability of effective training and practice can be formed to the student onboard, at shore officers or at maritime education and training institutes.

well designed PC based simulator tools should include the simulation module, the expertise module, training module and the trainee module.

1. The simulation module allows the trainees to manipulate variables in the learning environment and observe the actual model of a situation.
2. Declarative, procedural, and heuristic knowledge are contained in the expertise module. The origin for the qualification and a standard for assessing the trainee's performance is an expertise module.
3. The field of expertise which guides effective and adaptive instruction is the training module.
4. The trainee module is used to model the student's performance, predict student misconceptions, and recommend correction.

Death or injury, serious damage to apparatus or machinery, considerable commercial damage and the loss of customer reliance could be caused by the outcome of a mistake while conducting some jobs and activities. The only cost-effective method of training to be considered is presumably PC based simulation training.

2.4 Key features of PC based simulator

A common feature of all simulations is that they attempt to provide and operate an imitation of a real activity. Just now this is achieved will vary with the nature of the simulation. The essential form of the ship manoeuvring simulation is the creation of a dynamic representation of the behaviour of a ship in a manner which allows the human operator to interact with the simulation as a part of the simulation. In recent years, ship handling simulators have been produced with growing rapidity. They are used for training skill development and assessment. Most of these use costly and high performance visual systems. A compact, low cost ship-handling simulator designed to support ship-handling training and research applications has been developed. PC based simulation systems performing similar functions as those required of a shiphandling simulator using a popular and high performance IBM PC compatible i486/pentium personal computer with Graphic Signal Processor with sound card have been developed. PC based simulation has traditionally been limited to a radar view only. Nevertheless, a wide range of new possibilities have been made accessible by the increased graphics capabilities and power of personal-computers and advances in software technologies. A number of key visual cues, such as jetties, mountains, bridges and navigation aids can be represented by Computer Generated Imagery (CGI). The advantages of PC based simulator are its open architecture and continually updated hardware, its cost effectiveness, very easy operation and low maintenance compared to a full scale simulator. For application purposes, a networked simulation system could be easily set up and reconfigured.

> PC-based simulators have traditionally been limited to a radar view only. But today the graphics capabilities and power of PCs are such that many of the elements previously only found in expensive bridge simulators are now feasible.
>
> (Edmonds D, (1992) : 1)

The student to continue again with the same exercise when time permits is the key feature of a PC based simulator tools. The record replay feature is one further facility and when running the programme, the exercise is automatically recorded. To allow for debriefing and detailed analysis, the replay can be paused at any time. A very effective approach of training and evaluation students in a extensive and various extent of situation might be granted to instructors by a PC based simulator tool.

Since a PC based simulator training is an interactive training programme, multimedia technology allows user to study at his/her own pace when and wherever he/she wants.

Time will be wasted as trainees have to queue to use the equipment if there is a shortage of equipment in most practical courses which need the trainees to have access to equipment as and when necessary. This problem might be solved by using a PC based simulator tool.

Although some of the benefits which can be achieved by the use of simulation training, physical skills such as rope works, group or team skills where a group of people have to work together, the trade skills of a welder, painter, carpenter and the food preparation skills as cook are not suitable for a PC based simulation.

2.4.1 Hardware needs

All PC based simulator tools require at least one computer and in many cases a number of peripheral devices. Most PC based simulators run on IBM compatible personal computers. A significant requirement of investment in hardware is essential for the organisation. The quality of computer output must be as good as the quality of the data and the programs the computer works with; accordingly, the considerations of the cost of dedicated equipment and whether the system will run properly on existing equipment have to be taken into account. Existing computer equipment might not normally be used because most general purpose machines tend to have monochrome monitors, no graphics facilities, and limited RAM. Sometimes a general purpose personal computer might need to be upgraded for simulation by adding an interface card and a disc player. Compatibility of using the simulation programme and a large amount of dedicated hard disk space are also essential. The requirements of resolution and processing speed of the hardware need to correlate with the task demands. Additional enhanced graphics, a touch screen, a light pen or other peripheral equipment may also be needed by some special applications.

2.4.2 Software development

The availability of powerful desk top micro computers, networking, colour graphics and interactive work stations have made possible the rapid advance in PC based simulation software.

Manufacturers have developed large quantities of software in the specialised areas of shipping and port operations and business, naval architecture, cargo loading and stability, navigation and general support areas. The creation of integrated Ship Operational Centre Training Systems can be provided by the microcomputer network based simulator.

Major simulator manufacturers have developed methods of analysis, design, production and testing of simulation software so as to make a disciplined structure in their software. Software development procedures can be broken down into the following phases ;

- Analysis phase
- Design phase
- Production and testing phase
- Software integration
- Hardware integration

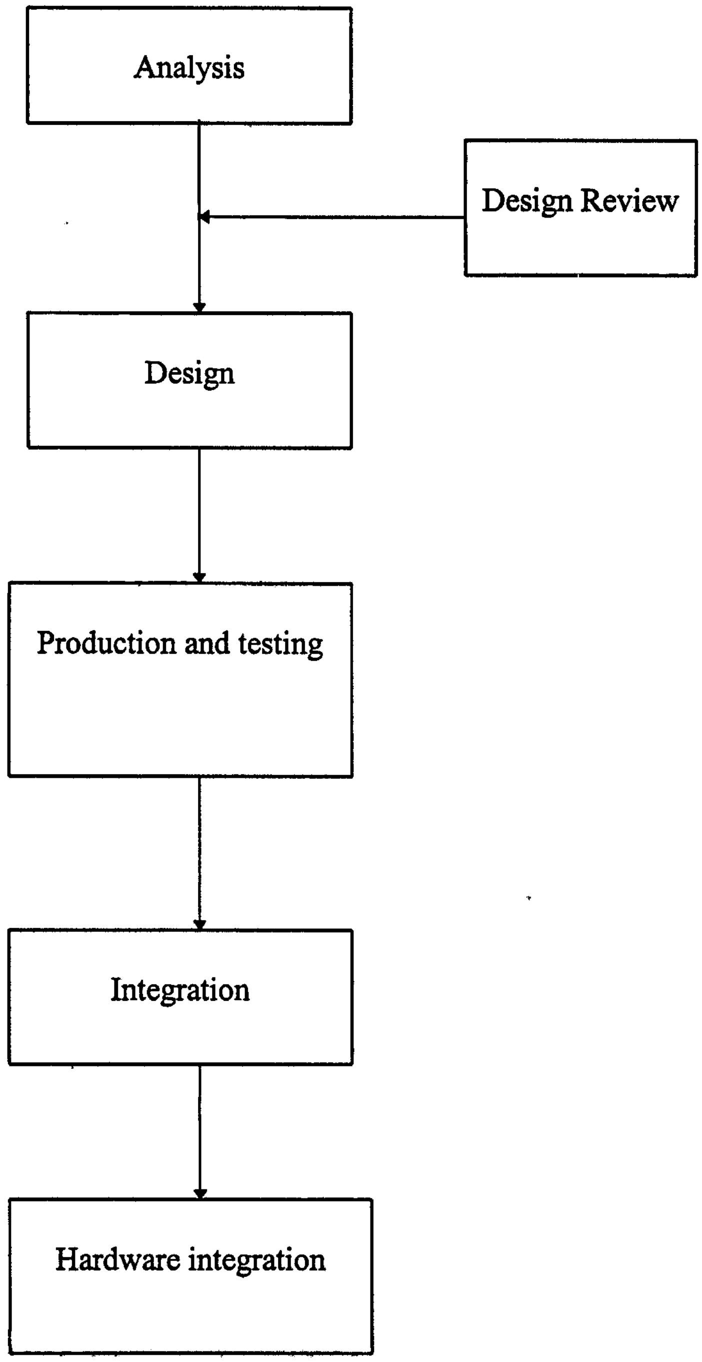

Fig : 2.1

Adapted from : Software development procedure (Rolfe and Staple, 1986, page 187)

2.4.3 Types of PC based simulation: Factors determining choice

According to Alessi and Trollip, computer simulations include many different types of experience and have been classified in a number of ways:

1. Process simulation, in which the student selects the values of various parameters of a situation and then watches the process occur without further intervention
2. Physical simulation, in which difficult-to-obtain physical objects are displayed so that the student can learn something about manipulating them in a simplified environment
3. Procedural simulation, in which the student learns the correct sequence of steps for carrying out a procedure or diagnosis

It is fairly certain that a PC based simulator cannot simply be plugged into the training programme. Carefully analyse the total training process and the application of the simulator to those functions for which it is best adapted.

2.4.4 The need for fidelity and validity

Every lesson of a simulator tools course must be validated before it is formally introduced into the training programme. The assumption behind the use of the simulator for training purposes is that the user controls the simulator in the same way as he would the ship. Although it is impossible to copy on the ground all characteristics of a ship as seen by masters or officers who serve on board, the purpose of the validation exercise is to demonstrate the truth of this assumption.

> Validation is the process of building an acceptable level of confidence that an inference about a simulated process is a correct or valid inference for the actual process.
>
> (Richard L. Van Horn, 1971)

The validation process can be separated into different kinds:

- investigation of data sources can be made;
- comparing of specification to the performance of hardware can be created;
- calculation of the response to control inputs can be designed individually, and then compared with the equivalent response measured in the simulator;

The fact of all-digital modelling coming into existence has helped notably in achieving good validation.

The fidelity of the simulator is supported by the validity of the results from the simulator training program. The simulator must design a visual image that has the qualities of fidelity and accuracy. An important aid in teaching ship handling simulation is the fidelity of the visual image and its true to life quality. Good fidelity means not only that the picture looks real but the relative sizes and relationships of depicted objects appear lifelike and not distorted. The fidelity and correctness of the visual presentation is directly proportional to the significance of simulation for training shiphandlers. A picture that remains undistorted is required and provided for accurate visual bearings at the same time by skilful and effective training. The solution to a problem or valid information can be provided by a simulation, only if the elements of the solution or the information reside in that simulation.

The effectiveness of a simulator is not simply a function of the realism of simulator. How the device is used and the quality of instruction will have a significant influence on learning.

The user, together with the specific understanding of instructors, has to take into account the applicable course in detail prior to setting up training simulation. Validation is essential afterwards in order to measure the transfer effect and evaluation of training results.

2.5 Cost and capability

Software costs are low compared to the potential benefit. The potential benefit might be the costs compared to a full mission simulator, portability, maintenance, etc.

The cost of PC based simulation for hardware will depend on the type of computer and associated equipment, the processing power of the computer, the capacity of RAM and hard disk used, whether the monitor is monochrome or colour, whether the monitors are low or high resolution, and the number of systems purchased. The capability of simulation depends on the characteristic of hardware and software used. The correlation between capability and costs is of significant effect on one another.

It is very feasible that certain advances in new technology will be used to enhance simulation capacity of PC based simulation.

2.5.1 Cost

Judgment about costs is influenced by the purpose for which the equipment is needed and how the equipment is to be used. It is also difficult to determine the costs of the particular products because many suppliers appear reluctant to quote a price for their products. They also tend to charge a different price for individual users and for institutions such as training schools. Typical costs which can be found are the initial registration fees and for simulator software, additional charges might also be paid for renewal or upgrading of the software. Usually most of the suppliers offer reduced prices for a training institution than a single user and also prices are dependent on the quantity of the order.

The costs of a traditional training course will always be less than the simulation training course but the extra costs will generally be offset by reduced running charges such overhead charges.

2.5.2 The effectiveness of simulation

Effective simulator training is reliant upon several factors. Muirhead (1995 b) has listed four common factors in simulation training:

1. Development of specific training objectives.
2. Selection of tasks relevant to the training purpose and operational skills needed on board.
3. The effective use of pre-briefing, control, monitoring and de-briefing techniques by the instructor.

4. The provision by the simulator of a suitable operating environment for the selected objectives and training tasks.

Rolfe and Staples argued the following statement.

> A common feature of all simulations is that they attempt to provide an operating imitation of a real activity. Just how this is achieved will vary with the nature of the simulation.
>
> (Rolfe and Staples, 1986 , page 2)

It is now generally recognised that the effectiveness of simulation is that students or trainees can manipulate variables in the learning environment and observe the concrete models to better understand the processes, causes, or procedures. Intelligent learning environments include a wide range of experiential uses of the computer such as simulation. In the simulation module, an outline of real life situations or an imitation of real world objects may be transformed. The computer is allowed to respond to the trainee's actions by a model of the situation. Since simulation modules provide a link to exploratory learning environments, they are significant. It seems that safety which would not be possible in a real world experiment and reducing costs might be provided by simulations.

Instructors and trainers have been aware of the effectiveness of audio visual presentation. The aim of simulation is to increase student control and the opportunities for exploration and discovery. Although the goal of a simulation programme is only one, a well designed simulation programme may offer the operator several different routes, a number of pathways and corrective loops used to aid understanding. Efficient, effective and highly motivational instruction that can readily serve the need for individualisation can be provided by PC based simulations. The transfer of learning by teaching complicated tasks is also enhanced by simulation. The facilities which allow trainees to develop their own learning strategies and the best use of their individual abilities and talents are provided by well designed PC based simulations. A trainee is allowed to explore real world applications by the simulation module. A shortage of well trained instructors, a changing curriculum and severe financial constraints are pressures on maritime education and training establishments. The use of simulator tools as an additional resource has a role to play in meeting these challenges. Although simulation can provide some resources not otherwise available, it cannot replace instructors or trainers. A PC based simulator is one of a range of training devices which can supplement on board experience. Every effort must be made to select and use the appropriate device.

Reinforcement and testing of knowledge, assessable training results, development of analysis and decision- making skills could be achieved by an interaction.

The following groups are also vitally significant to the effectiveness of simulation:

- The Manufacturers: who develop hardware and software to meet training requirements.
- The Purchasers: who desire to fulfil their training task more economically and efficiently.
- The Authority: who is accountable for designating what training is permitted in simulators substituting for equipment used onboard.
- The Training Technologist: who must assist the manufacturer, purchasers and Authority by conducting research to provide information to aid their decisions.

2.5.3 Conclusions

Some maritime institutions in developed and developing countries have been using full mission navigational simulators for many years. Only the richest training centres could afford such devices on account of their high prices. The smaller marine training schools or other marine based training institutions with small training budgets could not afford to purchase such full mission navigational simulators. A new situation has been created in maritime education and training programmes due to a drop in computer prices and the rapid development of technology and graphics. The abilities of easily accessible and comparatively cheap personal computers leads to the design of quite sophisticated training programmes which are very useful in the navigator training process.

The result of improving trainee ability is achieved by getting access to equipment as and when required. If necessary the system can be modified. Staff are free to work on other activities and the workload is reduced by using PC based simulator tools.

Simulation programmes which have been developed are relatively simple to install. The availability of full mission simulators can be located at suitability outfitted training centre because they are large and hard to be relocated. The time for accessibility of a full mission simulator to trainees is reduced by the use of a portable PC based marine simulator. The student can select the exercises himself and the reconfiguration can be done by the instructor. For the development and assessment of knowledge and skills, a specific role to play of a PC based simulator tool in maritime training is an additional and parallel to conventional trend of training.

A PC based simulation can be an energetic means of teaching, maintaining and assessing training skills. To ensure effectiveness requires a detailed preliminary analysis of the training task and subsequent evaluation to verify training and cost effectiveness. The customer must identify his training task and the role that a simulator will play in meeting the task. He must then produce a detailed specification for the simulator which must take into account the legislative requirements the device must meet.

For a full-mission simulator the capital and operating costs are high. To use a full-mission simulator for training may involve additional maintenance and replacement component cost. The use of PC based simulators for training and assessment can result in considerable cost reductions.

A PC based simulation offers the prospect of considerable saving which includes the financial cost of providing hardware, software and courseware.

On the whole, it can be said that the main benefits of PC based simulation is as an open learning tool, freeing up valuable staff time. Assisting in situations where qualified and experienced staff are not available, a design which allows cost - effective training and excellent interactive, feedback and assessment facilities could be achieved by the use of PC based simulator tools.

CHAPTER 3

SOFTWARE APPROACH TO PC BASED MARINE SIMULATION

There are a number of different PC based simulators on the market. The more sophisticated have visual scenes and electronic charts systems built into them. As with any computer based system, the quality of simulation performance lies in the quality of its software. The lack in quality of software will lead to the failure of simulation training in marine simulation.

Every institution involved in providing and using training through PC based simulation should move with considerable caution. PC based desktop simulation packages that do not meet the training needs can result in a situation in which an over confident crew member undertakes a duty above his actual level of competence. The resulting situation is fraught with danger for everyone involved. As a result, software approaches to PC based simulation should not be underestimated. The generation of the text, graphics, the display of video images on to the monitor and the interaction are controlled by the computer software, the visualization of the display of computer-generated material, video material or a combination of both is determined by the software.

The following criteria should be examined for assessing the quality of software which is intended to be utilized:

- Faultless (the program works as designed) and reliability.
- Efficiency and correctness of the content contained must be examined carefully.
- Easy installation and easy interaction between the user and the system.
- Software should be well structured and conform to education and training principles and to international marine regulations.
- Software should be expandable to ensure that the system can grow with the future requirements for training.

Manufacturers should supply well prepared documentation to the user, typical documents should include user requirement specifications, functional specification, any information on customizing the system for different hardware, software design documents, test plan and results installation procedure and technical issues such as equipment, memory requirements, description of objectives of the system, etc. The information for the user should be clearly laid out. The selection of software must be compatible with the hardware that is intended to be used. The level of the trainees should be adapted to the software selected.

During the past few years manufacturers have produced different types of marine oriented PC based simulation software. The different types of software available on the market are:

- Ship manoeuvering
- Radar and Radar navigation
- Diesel engine simulator
- Engine room
- Cargo and ballast control

- GMDSS
- Oil Spill Management Trainer
- VTS and Simulators with a visual ship manoeuvering capability
- Cargo secure simulator for the investigation of lashing forces

3.1 Current PC based simulator software products

3.1.1 Portsim

SPPA MARITIME CONSULTING AB has launched a PC-based ship manoeuvering simulator, PORTSIM, which is designed for training officers of specific ships for manoeuvering in specific ports or fairways under different weather conditions. In addition, PORTSIM can be expanded with a link to the expert program SHIPGEN and PORTGEN to provided and advanced simulation tool, with broad application areas for designers, consultants schools, etc.

PORTSIM is a PC-based training simulator which runs on any 100% IBM compatible PC 486 (including co-processor), with 20 MB hard disc, 640 kB RAM, VGA color graphics screen, mouse and one parallel port.

Opportunities for effective simulations, repeated training examples, documentation of manoeuvering investigations are offered by the replay function. Any simulation can be stored and recorded on file. In manual mode, the replayed simulation can be interrupted or stopped and continued at any time.

PORTSIM offers an effective tool for investigating and developing safe operations assessing risk situation and determined 'safe weather window's in real or compressed time. It might be a good training tool/ planning opportunities for all officers concerned on-board.

3.1.2 Poseidon GMDSS/GOC Simulator

Poseidon Holding AS (Ltd.) has produced POSEIDON GMDSS/GOC simulator, a software product, which is designed to assist Maritime Training Institutions (training centers) and instructors with the organization, introduction and presentation of a *Global Maritime Distress and Safety System GMDSS* course.

The Poseidon GMDSS/GOC simulator consists of a number of computer stations connected by a network system together with an Audio Multiplexer Unit (AMU), headsets and printers. A maximum of 16 computers (1 instructor and 15 trainees) have been allowed to work together.

The various means of marine communication referred to in the GMDSS regulations are included. To improve the reception and handling of distress traffic is the main aim of GMDSS. The instructor station is connected to all the trainee stations to pre-set simulated parameters such as a sea area, and position data for each trainee. The simulated functions of a multi role capacity such as coast station, ship station and shore subscriber can be undertaken by the instructor station. A GMDSS/GOC simulator encompasses a number of selected charts or exercise maps to enable the instructor to pick the individual training area for the initial location of the trainee ship and the coast station. A full list of map areas is attached. Each trainee will be communicated with by the instructor via the communication system assigned. Emergency signal emissions can be simulated without actual signal disturbances.

This PC based simulator can provide the trainee with repeated training for distress, search and rescue communication with the same sensation as at the distress site. By using this software product, trainees can be familiarized with the correct operation of GMDSS equipment for emergency and distress communications as if they were operating the actual equipment on board ships. Trainees can undergo exercises in practical search and rescue procedures as well as in the operating procedures of general and non-emergency communications using the GMDSS radio equipment. All students and the instructor are able to communicate with each other, both by voice and text provided that they are within the range area of the communication system in use. The required scenario for each exercise can be designed by the instructor. The exercise area can be chosen from the list of charts and it will be shown on the screen.

Storing and retrieving of the exercise can be executed and the exercise set-up can be printed out. New chart areas can be added by upgrading the software.

The operation of all allocated instruments are settled by the Poseidon GMDSS/GOC simulator.

Although the Poseidon GMDSS/GOC simulator is basically a software product, the manufacturer will supply the Audio Multiplexer Unit (AMU) units with a power supply and an audio network with headsets and their cabling.

The following minimum computer configurations are required to run the simulator software properly:

- IBM Compatible PC, i386 (16 Mhz)
- Mathematics co-processor
- DOS v 5.0 or better
- 4 Mb RAM

- 10 Mb HDD free space 1 3.5" FDD/1.44 Mb
- VGA color monitor
- Keyboard (English alphabet to be used)
- Microsoft compatible mouse
- 2 serial ports
- 1 parallel port
- 1 10 Mbit/sec. Ethernet-compatible netcard w/NETBIOS software. cable, connectors and terminators
- 1 IBM Proprinter compatible printer

Comprehensive Instructor and Student operational manuals can be supplied with each system by the manufacturer. The trainee stations can be easily increased as an option to maximum (15) stations depending on the customer's needs.

3.1.3 Officer of the watch simulator

PC MARITIME LTD has developed the "Officer of the Watch"(OOW) PC based simulator. The program is relatively simple to install. This software is designed to teach all the procedures and strategies for minimizing the risk of collision at sea. The whole package of OOW software contains two programs:

1. the Officer of the Watch simulator and
2. the Officer of the Watch Course Designer.

The Officer of the Watch (OOW) simulator provides exercises which are fulfilled in real time with realistic 3 Dimension animation in clear or restricted visibility and by day or night including dawn and dusk. The OOW simulator can be used for guided or self study. A facility is provided for jumping forward to remove delays between making decisions and observing their effects. The Officer of the Watch (OOW) software is designed for international navigation rules. The simulator contains the expert system which controls the actions of all simulated ships (except own ship and rouge vessels) and advises the student who needs guidance and interpretation of Collision and Regulations if the instructor has allowed access to the expert system.

The Officer of the Watch Course Designer lets instructors create exercises which can cover their own teaching requirements. Trainees can be allowed to work pre-programmed exercises either under guidance or away from the classroom environment, as part of a distance-learning course. OOW allows the user to choose any of the vessels listed in the OOW Course Designer as his/her own ship, ranging from a VLCC to a fishing vessel. Varying types of rain are also possible to program into an exercise. In addition to standard lessons, exercises in different areas, different kinds of traffic density, sea state and environmental conditions can be designed. The OOW simulator provides a fully functional relative motion radar with all the standard facilities which conform with the latest International Maritime Organization approved control symbols and can be head-up or north up stabilized.

A choice of ship types, including a tug with tow and a fishing vessel, is provided. Insertion of way points can be introduced to direct a traffic vessel on a specific route. All the actions taken by the trainee (use of radar, binoculars, changes of course, results of questions and responses taken during the test, the percentage and actual time spent using the bridge view and radar, view direction selected, the percentage and actual time spent looking in each view direction, all whistle signal sounded, etc.) are automatically recorded by Officer of the Watch. The replay can be available for the instructor who can pause the action at any time to review a trainee's watchkeeping procedures, to analyze, to assess performance ready for debriefing. If time permits, the trainee is able to carry on again with the same exercise. Timed equipment failures, such as radar, steering or engine can be introduced. These failures may help the student in making a correct decision for particular circumstances under supervision by an instructor.

A facility for designing questions which can be the sole content of a lesson or be introduced at a specific time to test the trainee's response is provided by OOW software. Self evaluation and evaluation by others can be adapted. One exercise area is available in respect of the electronic chart. A traffic separation zone, narrow channel and a sort of inner harbour area are incorporated. The user or instructor can place the navigational marks anywhere within the exercise area and both IALA 'A' and 'B' systems of buoyage are obtainable..

The following hard requirements are necessary to run the OOW simulator and OOW Course Designer.

- IBM (or IBM compatible) computers with color display.
  The computer must be fitted with:
- A mouse (Microsoft mouse type or compatible)
- At least one hard disk drive
- A least one floppy disk drive
- 80386 processor with co-processor
- IBM VGA, EGA 16 color (or compatible) video adapter with minimum 640x480 pixels, is necessity
- Any Epson compatible dot-matrix or HP compatible laser printer

The ship models provided are realistic, with respect to draught and manoeuvring using the engine and steering controls. However, it is not a ship handling simulator since the sophisticated art of interaction with other vessels or narrow channels is not encompassed.

3.1.4 Mariner

Baron and Dunworth Pty Limited offers software-based training systems concentrating on the areas of loading and discharging operations and the possibility of checking the current sea-going and harbour status of the ship against the requirements set down by IMO.

The fundamental aim of this software package is shipboard operations. It helps the student to approach the practical problem of load distribution in a holistic manner. Well-structured exercises, utilizing the MARINER, can be used by maritime institutions to promote the trainees' proficiency in applying the knowledge he has.

Mariner is a stand alone software, having been tailored to exact characteristics of the ship for which it is designed. It can be run directly from floppy disc or it can be installed on the hard disc.

At the top of the screen is a profile of the ship with ship's name. On the left of the lower portion is a table showing the following current status of the ship:

- The displacement
- The spare capacity
- The height of the centre of gravity above the keel (KG)
- The longitudinal centre of gravity (LCG)
- The metacentric height of the ship (GM)
- The seawater specific gravity (S. G)
- The trim
- The forward draft
- The aft draft

- The shearing forces and bending moment, showing a percentage of the allowable forces for sea and harbour conditions. Any figure of unsatisfactory condition is displayed in red.

At the right of the lower portion is the menu bar, displays the different menus that are available in the program. Four choices are available: **File, Edit, View** and **Quit**. Apart from the **Quit** menu which facilitates to exit from Mariner and return to DOS, accesses to pull-down menus are rendered by each of the other three options.

The **File** menu lets the user to manage the program. It contains seven alternatives:

1. Load (A previously created and saved condition can be recovered or retrieved and if the current condition has been changed it will prompt before saving the new one);
2. Delete (Undesirable already saved conditions can be erased);
3. New (Generating of a new condition is applicable);
4. Save (The current status of condition can be entered);
5. Title (Editing or entry of new title can be inserted);
6. Freeboard (Selection of Summer or Tropical loadline is available);
7. Water S.G.(The entry of the specific gravity of the water is accessible in the range 1.0 to 1.03).

The **Edit** menu allows entry of new data such as the amounts of cargo, ballast, oil, fresh water and minor tank contents to generate a new loading condition.

The **View** menu displays the displacement summary, stability status, longitudinal strength and report (this option allows the user to have hard copy of the work done through printer). Moreover, mariner generates:

The Displacement tables which show the overall conditions of the holds and status of tanks including the percentage of allowable conditions for the shear force and bending moment.

The Stability conditions illustrate the intact stability diagram (Righting lever, GZ, curve, the intact stability table, and damage stability diagram).

Longitudinal strength conditions are shown in the form of tabulated values. The value of shear forces at critical points along the length is shown on the table of shear forces together with the allowable seagoing and harbour value. The moment produced along the ship is illustrated by the bending moment diagram.

Appropriate load distribution is very crucial for the safety of bulk carriers. Classroom instructions may satisfy the need to train the student in the use of IMO Stability Criteria and Calculation of Grain Stability Criteria. Mariner will improve the trainees knowledge about the subject.

3.1.5 NAVI-TRAINER

TRANSAS MARINE has developed NAVI-TRAINER personal marine navigational simulators designed for both beginners and experienced sea navigators.

The NAVI-TRAINER is available in different versions for different applications and requirements. These simulator sets contain:

- system of testing and training programs;
- system of training data preparation;

- vessels' mathematical models;
- sailing imitator;
- results analyzer and archiver;
- modules for exchange of information between the trainees' and instructor's computer;
- Program module of the instructor's working place.

The module structure of software packages for simulators has been provided. The features of base module that may or may not be extended with specific features of additional modules are always contained for each particular version. The NAVI-TRAINER have been categorized according to the level:

- Educational level versions designed for those trainees who have no certificates;
- Professional level versions of the series designed for the simulation training of navigators followed by issue of International Certificates of Radar Observer, International Certificates of ARPA Operators and International Certification of Vessel Control Simulation Training.

Any versions of software can be upgraded or modified to the next version to meet customers' requirements within its level (Educational or Professional).

The following training procedure capabilities are offered :

- facility for accumulating data on training procedure;
- facility for creating one's own exercises meeting the principal requirements regarding simulation training procedure approved in the international practice;
- facility for printing out records of fulfillment of exercise, which contain all data required for the trainee's certification.

The following hardware configurations are necessary to run NAVI-TRAINER:

- IBM PC/AT-386/486 or compatible with at least memory space of 2 MB;
- MS-DOS operation system of version 5.0 or higher;
- Graphic VG adapter and color monitor;
- Mouse or trackerball manipulator (optional);
- Graphic printer of one of the following types: Epson or HP paint jat, or HP laser jet, or compatible (optional).

3.2 Conclusions

Price, appropriateness to the particular training needs, hardware required, and support services such as installation, training, updating, data entry would be regular considerations for software approaches. On this basis, it can be deduced that the institution does not have to pay for capability that it does not need or can postpone.

MARINER is a very able learning tool. It helps the student to approach the practical problems of load distribution in a holistic manner. It does not purport to enhance the theoretical knowledge of the student, however, it can help a student who already has a sound theoretical knowledge to address the problem and seek solutions. It allows the student to experiment and find out what to do and how to do it. Well-structured exercises, using the MARINER, can be used by nautical schools to develop the trainee's capability to apply the knowledge that he/she has. These exercises can get progressively more complex to reflect all the variations seen in real-life situations. Provided certain performance criteria are established, this program is also an excellent tool for evaluating the competency of the candidate in the function as a Cargo Officer on board a bulk carrier. As a computer based training program, it involves a high degree of trainee activity and interaction and has proved to be a tool for improving training results.

The OOW PC based simulator includes all the features of modern simulator structure:

- Flexibility which allows the use of the system for all level of training,
- Expandability, which ensures that the system can grow with future requirements in training,
- Functionality which guarantees easy interaction between the operator and the systems and
- Reliability that guarantees continuity in the systems operation and saving costs.

The OOW software is designed to provide for practicality and repetition where needed and interest level is constantly raised as a result of lessons which are progressive in complexity.

Navigational PC based simulators such as NAVI-TRAINER and PORTSIM have a specific role to play in navigational training and this role might be additional and parallel to formal courses and full-scale bridge simulators.

The POSEIDON GMDSS/GOC simulator can be used as an approved training tool onboard or ashore. The revised STCW(78) Convention has allowed the use of GMDSS simulators for both training and assessment (Table A-IV/2 of part A of STCW Code).

CHAPTER 4

The impact of the revised STCW Convention on MET programs

The most influential development on the subject of the enhancement of maritime safety for over a decade has been the adoption of significant amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, in July 1995.

The Convention should be implemented effectively to increase safety of life at sea and the protection of the oceans from pollution.

The adoption of a new STCW Code annexed to the Convention, which incorporates the technical provisions associated with the regulation by cross reference, is the most apparent modification. The Code has been divided into two parts: Part A and Part B. The main difference between Part A and Part B of the Code is that Part A of the Code is mandatory, whereas Part B of the Code contains recommended guidance.

The revised STCW 78 Convention has set forth the specification of minimum standards of competence required for sea going personnel in detail in a series of tables which are included in Part A of the Code.

So as to fulfill a consistent approach to the implementation of the Convention standards on a global basis, Part B of the Code should be considered to the greatest degree possible.

The importance of the acquisition of skills, the functional approach to certification and the demonstration of ability to perform tasks have been highlighted in the revised STCW 78 Convention. The establishments of precise standards of competence relating to the actual ability of seafarers to perform their tasks safely and effectively have been laid down by the revised STCW Convention.

It is fairly certain that the amendments will enter into force on 1 February 1997. However, parties are allowed to issue, recognize and endorse certificates in accordance with existing 1978 practices for those already in the system for a period not exceeding five years (until 1 February 2002). On 1 August 1998, new candidates commencing training will be required to do so in accordance with the standards of the revised STCW Convention, which have been adopted.

A new addition to the revised STCW is Regulation 1/12, 'Use of Simulators', which includes provisions covering the use of simulators for training, any assessment of competency and any demonstration, by means of simulator, of continued proficiency required by part A of the STCW Code. The use of simulators for training has only been made mandatory in the case of radar and ARPA. Performance standards for all mandatory simulator-based training are established and an exemption for full compliance with the standards is given for simulators in use or installed prior to 1 February 2002.

A number of new sections in relation to the use of simulators which simulator users need to become acquainted with are:

- The Use of Simulators;
- Standards of competence for deck, engineering and radio operators;
- Training and Assessment;
- Alternative certification;
- Quality Standards

4.1 Emphasis on competency based training and assessment

The notions of 'competence' and 'function' are essential elements included in the approach which is adopted to develop precise standards of competence pertinent to all of the safety and pollution prevention tasks that must be performed on board a ship.

'Competence' represents small practical units of ability that can be readily assessed. For example, the ability of planning and conducting a passage and determining positions relating to tasks and skills (knowledge, understanding and proficiency) to be used are:

- Celestial navigation
- Terrestrial and coastal navigation
- Electronic systems of position fixing and navigation
- Echo sounder
- Compass
- Steering control system
- Meteorology

'Functions' comprises competencies for all of the tasks, duties and responsibility needed to be achieved. For example, the function of 'Cargo handling and stowage at the management level' involves the competence essential to:

- Plan and ensure safe loading, stowage, securing, care during the voyage and unloading of cargoes
- carry dangerous cargoes

Seven functions have been defined by the revised STCW 78 Convention:

1. Navigation
2. Cargo handling and stowage
3. Controlling the operation of the ship and care for persons on board
4. Marine engineering
5. Electrical, electronic and control engineering
6. Maintenance and repair
7. Radio-communications

As mentioned before, the use of simulators for radar and ARPA training and as a method of demonstrating and evaluating competence, both at the operation level and management level, is the only prescribed mandatory requirement.

In all respects, all competency based training and assessments of seafarers for certification by using simulators have to be well structured and conducted, monitored, evaluated and supported by persons qualified as required under the Convention, in accordance with the regulation I/6 and section A-I/6.

According to Table A-II/1 and Table A-II/2 of section A of STCW Code training and assessment in the use of ARPA is not required for those who serve exclusively on ships not fitted with ARPA. But this limitation will be reflected in the endorsement issued to the seafarer concerned.

> It would seem likely that any officers in the latter category seeking certificates of competency would not wish to be disadvantaged in the market place by the lack of such qualifications.
>
> (Muirhead, 1995b)

It is widely accepted that the concept of certifying seafarers' competence is not new. Trainees' skills and knowledge at entry and their progress should be evaluated by a good assessment method. A wide range of assessment methods is being used in shore-based and sea training programs. The assessments of skills to specified standards, appropriate knowledge and understanding, proficiency to use skills and to apply knowledge and understanding to the performance of relevant tasks are incorporated with a statement of competence. Standards pertaining to the master and deck department, the engineering department and radio personnel are explicitly stipulated in the Chapters II, III, IV and VIII of Code A.

It is fairly certain that the performance standards for simulator equipment, the written programs and qualifications of instructors, supervisors and assessors are significant factors in obtaining optimal results from simulator training. In addition, the following considerations should be taken into account when simulators are being used for training or the assessment of competency:

- sufficient time for briefing and debriefing;
- methods of documenting an exercise such as instructor's notes, trainees log book, X/Y plotter, etc.;
- follow up by instructor during exercise.

Guidance regarding the use of simulators (Section B-I/12) should be practiced to achieve the optimum result of assessment.

4.2 Onboard training and companies

In a number of cases, the best training is that which relates closest to the real task unless actually on the job. The reason for onboard training is to learn realistically by being as near to the genuine knowledge and experience as is conceivable.

To be effective, onboard training needs to be well planned. Qualified personnel have responsibilities for ensuring the efficiency and safety of operational procedures. These responsibilities comprise familiarizing all staff onboard with the ship equipment, installations, implementing safe procedures for routine operations and ship characteristics that are appropriate to their routine or emergency duty. Furthermore, these responsibilities should be explained in detail in a company training procedure. To set practicable objectives, to heed the assets available and to use them efficiently are essential to fulfill the training objectives. The skill and experience of instructors are likely to be major assets. Allocation of responsibilities among appropriate professionals who are accountable for training is also very considerable. It is impossible to advise people to use training aids if one does not know what each one covers. Because of this, training aids should be provided including manuals and instructors should make notes on the contents of these manuals. The companies need to be contacted if the training aids required are inadequate.

The following considerations should be taken into account to meet the training objectives:

- Level of trainee to be trained;
- Time required to be allocated for training;
- Methods of training to be used;
- Time available for trainee to be involved;
- Subject area to be transferred.

Regulation I/14 and Section A-I/14 of the Code of revised STCW 78 Convention is concerned with the responsibilities of companies. All seafarers must be provided with familiarization training onboard. In addition, section A-I/14 requires companies to provide written instructions to the master of each ship setting forth the policies and the procedures to be followed. It needs to be ensured that all seafarers, who are newly employed, receive familiarization with the shipboard equipment, operating procedures and other arrangements needed for the proper performance before assigning to those duties. Familiarization training requirements will vary from ship to ship depending on the types of the vessels. Guidance regarding special training requirements for personnel on certain types of ships is included in Chapter V of part A and part B of the revised STCW78 Convention. Company training policy should include detailed training objectives that are realistic and procedures including the regulatory framework, safety and operational efficiency objectives, responsibilities of managers, trainers and trainees, monitoring (keeping of training record books).

It is now generally recognized that training vessels are becoming increasingly limited, especially the non-sail type dedicated to long training voyages. Well structured, portable, PC based simulator tools might be exceptionally beneficial for improving motivation and encouraging awareness of the need for safe and efficient operations. Trainees can monitor the progress of the training session as it continues and be advised on repeats or remedial learning which is to the advantage of the trainees when onboard training.

The usual methods for demonstrating competence practiced on board would involve:

- practical demonstration of skills;
- computer-based assessment;
- simulation exercises with computer based monitoring;
- written examination.

These methods should be conducted effectively by the qualified assessors.

4.3 Simulation

The revised STCW78 explicitly approves the use of simulators as a method of demonstrating and evaluating competence. Training in the correct use of radar and ARPA as a navigational aid and for collision avoidance is now mandatory. The simulator can create a dangerous circumstance which does not really exist, repeat the same situation, produce any place and any condition in a training environment, modify parameters easily to the condition required, train students economically and in a short time, study human performance under stress and study man-machine interaction.

It should be recognized that skill transfer can be achieved effectively by simulation if it is properly applied.

Part 1 of section A-1/12 deals with performance standards for simulator used in training. Under the mandatory part of the code, each Party shall ensure that the simulator must be able to simulate the operating capability and physical attributes of actual shipboard equipment to such an extent that the selected objectives and training tasks are met. Possible errors and limitations of actual shipboard equipment must be incorporated in the simulator in order to make an appropriate level of realism. The simulator should be capable of simulating a controlled operating environment including emergency, hazardous or unusual condition. Interactive interface between trainees, equipment, the simulated environment and instructor or assessor must be provided. Controlling, monitoring, and recording exercises for the systematic debriefing of trainees must be permitted for simulator-based training.

Additional performance standards are prescribed for radar simulators. The following facilities have to be incorporated in radar simulation:

- ground and sea stabilized display
- relative and true motion modes
- model weather, tidal stream, current, shadow sectors, false echoes and other propagation effects, and generate coastline, navigational buoys and search and rescue transponders
- at least two own ship stations and twenty target ship stations (with real time operating environment)
- appropriate communication facilities

Specific additional requirements are prescribed for ARPA simulation equipment. The following facilities shall have to be incorporated:

- manual and auto target acquisition
- past track information

- use of exclusive areas
- vector/graphic time-scale and display
- trial manoeuver

Recommended performance standards for non-mandatory types of simulation equipment used for training and/ or assessment of competence or demonstration of skills are prescribed in section B-1/12 of part B.

4.4 The effective use of PC based simulation system

It has been suggested that PC based simulators are used to the best advantage when they provide structured learning. The element of this is interaction and response. Effective training and practice can be made obtainable to the trainee onboard and ashore through the portability and flexibility of well-structured PC based simulator tools.

If assessment of any competency, or demonstration in any proficiency required by Part A of the code is to be carried out by using PC based simulation system, it is required to comply with the performance standards.

Several factors have to be taken into account before using effective PC based simulation system:

- Analyzing the role of simulation;
- Specific training objectives have to be developed;
- Statements of the benefits from simulation that is to be put into use;

- Examination and selection have to be done relevant to the knowledge, skills, and personal characteristics essential for the performance of the tasks and the training purpose;
- Identifying the specifications of simulators that is intended to be used;
- An investigation has to be made for the specification of simulators that will be dependent on the requirement of the particular training scheme;
- Studying the simulation system chosen which must meet the requirements of the revised STCW78 Convention;
- The effectiveness of briefing and debriefing of trainees has to be considered;
- The qualification of instructors who conduct the simulation exercises;
- The information and contents of specific training objectives and training tasks must be provided to the instructor prior to the training program;

Great emphasis is placed on the trainee's experience. Trainees should be encouraged to share or pool their experience during the training to maximize the valuable knowledge resources. This method can be used only for the experienced trainees.

4.5 Conclusions

In conclusion, the revised STCW78 Convention comprises a wide range of provisions which include the use of simulators in training, standards of competence for deck, engineering and radio personnel, training and assessment, alternative certification, quality standards, the qualifications of training instructors, and methods for demonstrating competence.

The revised STCW78 Convention is divided into two sections:

- Part A" which contains mandatory requirements for all governments that are parties to the Convention.
- "Part B" which contains guidance and recommendations, non-mandatory; this part is very helpful for the party concerned.

Skill acquisition, knowledge, understanding and demonstrating competence and proficiency to be achieved in each element of competence by candidates for certification have been given greater emphasis in the revised STCW78 Convention.

Responsibilities of companies are stipulated and specific measures to be adopted to meet minimum international standards of competence are stated. Regarding onboard training, a comprehensive acknowledgment of training program and understanding of the specific training objectives have to be correctly executed by any officer conducting in-service training of a seafarer. As a result, the way to monitor and maintain these tasks has to be established. On board trainers and assessors shall have a thorough knowledge about training methodology and assessment methods. For this reason, those who are going to perform as qualified trainers and/or assessors need to be trained properly. According to regulation I/11, revalidation of certificates, every master, officer and radio operator is required at intervals not exceeding five years to establish continual professional competence in accordance with section AI/11 of the STCW Code. The use of simulators for training is mandatory for radar and ARPA only and in order to meet this requirement, a required quality specification is essential. Undertaking much of this training might be a preferable and desirable option on board ship.

The capital expenditure for simulator equipment varies with the type of simulator required. Accordingly, there is a tendency to favour the portability and flexibility of well designed and PC based simulators. In accordance with Table A-IV/2 of Convention, specification of minimum standards of competence for GMDSS radio operators, the simulator can be used as both an assessment tools and training device on board and these tasks can be carried out by PC based simulators.

CHAPTER 5

Instructor's facilities

It is now generally recognized that the need to improve training and identify new directions to upgrade the quality, professional competency and image of the maritime profession is essential. The provision of modern simulator facilities within the training and evaluation system should allow instructors and assessors to provide both the required knowledge, understanding, proficiency and thoroughly evaluate the trainees' competence. The unique capacity to assess a person's response to a variety of conditions should exist in a simulated environment.

5.1 Introduction

Specialized facilities are required to carry out the training responsibilities of the instructors who instruct and assess trainees in marine simulation. A composite set of facilities must be provided to instructors to prepare exercises in advance, to supervise exercises in progress and to debrief the trainee at the end of the exercises. The instructor may be an instructor onboard or ashore. It may take hours to complete an exercise or it may last only minutes. The overall design and integration of equipment should not overburden the instructor with control duties. Instructor's tasks and design of the instructor's station need to be related to the basic requirements that is dependent on the training objectives.

5.2 Role of the instructor

The factors that strengthen the learning rate of the trainee are manipulated by the instructor. It is necessary that the instructor's facilities include means of monitoring the performance of the trainee, comparing with the performance standard and feeding back the results to the student during the exercise itself or in the debriefing after the exercise. This type of learning depends on knowledge of results.

The following supplementary tasks have to be carried out by the instructor if he wants to change the simulated surroundings and the situation of the vessel being simulated in order to stimulate an appropriate response from the trainee:

- briefing the trainee before taking an exercise;
- initializing the simulator;
- simulating outside sources of information for the trainee such as vessel traffic control communications;
- instructing and correcting the trainee during exercise;
- updating records.

The means for performing these tasks are taken into account in the instructor facilities. The role of the instructor depends on the techniques that he applies to simulation training.

5.2.1 Skill needs

The effective use of PC based simulation involves trainees and instructors in the learning process in new techniques. The vitality of PC based simulator tools depends on skillful instructors. The competency of an instructor should be realized.

An instructor should understand the operation of simulators and the making of effective exercises. Accordingly, an experienced and well trained instructor is indispensable and he must have adequate knowledge as a watchkeeping officer in all kinds of navigation and traffic conditions.

A skillful instructor should be able to:

- understand the impact of PC based simulator tools in Maritime Education and Training;
- discuss how computers work and how they are used;
- describe the aim and primary aspect of applications software-simulation programs;
- assess and use simulation software in different educational environments;
- identify sources for maritime software and educational materials in appropriate subject domains;
- correlate learning theory and principles of a computer learning environment;
- argue major issues in the use of PC based simulation in maritime education and training;
- apply his knowledge of curriculum development to improve supplemental materials for use with a PC based simulation software;
- design, execute, and evaluate PC based simulations and related activities.

It is fairly certain that an instructor should have at least the same general knowledge as the trainees have to achieve the effective use of the PC based simulation system in maritime education and training.

5.2.2 Qualifications of instructors and assessors

The simulator can be an indispensable means of achieving training objectives. However, it must always be remembered that simulation is only a tool and as such its effectiveness depends on the qualifications of the instructors and assessor to analyze the key elements needed in the simulation and the ability to apply the tool in the correct way.

The instructors and assessors conducting the training and assessment are required to be qualified and approved by parties concerned according to the regulation I/6 of revised STCW78 Convention. These requirements have been explicitly established in section A-I/6 of the Convention. Each party, accordingly, has to ensure that the instructors using simulators have to be appropriately qualified for the particular types and levels of training or assessment conducted. Furthermore, the following mandatory provisions have to be met by any qualified person conducting training using a simulator:

- The trainer or instructor must have received appropriate guidance in instructional techniques such as briefing, monitoring, debriefing, etc. In order to ensure the quality and progressive development of training programs, the training method should outline the way in which training is monitored on board and ashore. In order for the trainee to acquire understanding about the outcome of the exercise, debriefing after the exercise should be of great significance. In addition the trainer must be experienced in the particular type of simulator being used and in practical operational techniques. The requisite experience might be acquired at various grades in different modes including shipboard experience, a simulator instructor course, knowledge of particular exercises to achieve an understanding of the overall scenario of simulation and organize in part for the discussion, the exchange of experience or previous instructor experience and proper training at regular training institutions.

- The supervisor should have a full understanding of the simulation training program and the specific objectives for the type of training.
- The assessor should have gained practical assessment experience on the particular type of simulator under the supervision and to the satisfaction of an experienced assessor. The assessor should be able to evaluate not only the effectiveness and the quality of the exercises but also the trainees achievements in the program performed.

In brief, simulator instructors and assessors should have knowledge regarding an overview of prevailing simulator aspects, evaluation, man-machine communication and design of exercises and programs related to simulator training equipment. In addition, it is required that instructors are familiar with the use of the equipment concerned with pedagogical background.

5.2.3 Staff training

It might be generally agreed that the large majority of maritime lecturers have a lack of formalized training in the use of simulators or no formal educational qualifications. Most of those achieve their training and educational skills through experience and experimentation. Formalized teaching staff training, however, will accelerate the process of quality teaching.

An increase in demand for qualified instructors lead members of teaching staff to conduct training sessions which can help them to promote their training methodology, teaching techniques etc. The simulator instructors will require staff training course to ensure that they perform their functions effectively.

After attending the staff training course, the qualified instructor should be able to:

- conduct appropriate principle of learning;
- set the realistic objectives;
- develop an exercise which meets the training needs;
- lay out the appropriate sessions and programs;
- select the strategies and methodology in effective teaching techniques;
- transfer concept and knowledge requisites;
- evaluate the trainees' achievements;
- evaluate the effectiveness of the exercise;
- monitor the use of training facilities and sources of information and materials for training.

Guidance in instructional techniques, practical simulator operational experience and practical experience on the simulator may be fulfilled by manufacturer's training programs, learning on the job, understudying at another institution and IMO model courses. The recommended structured IMO model courses on simulation training programs are:

1.09 Radar simulator

1.22 Ship simulator and Bridge Teamwork

2.06 Cargo and ballast handling simulator

2.07 Engine room simulator

In order to develop basic instructional techniques, IMO model course 6.09-Training course for instructors should be utilized.

To some extent, the instructors are still the same as those who began to operate simulators and who have to study how to handle those modern computer-based and more complicated simulators.

Furthermore, there is no doubt that the experience of an instructor should be up-to-date and representative of current shipboard practice. In that case, new instructors must be selected, trained and old instructors must continuously improve and update their own skills.

Institutions using simulators should be required to find ways in which a new instructor can be trained in order to become competent simulator instructors. Other possibilities might be:

* the establishment of national or international instructors training courses;
* simulator instructor training programs offered by the manufacturers;
* simulator staff training courses conducted by the shipping companies.

5.2.4 Conclusions

Using computers, like using any other media, should be directed at achieving some instructional purpose. Competency needs vary according to the discipline being taught, the curriculum, and the grade level. Computer software needs to be enhanced and extended by an enthusiastic instructor.

The qualified instructor must be able to select and evaluate software that must meet the training objectives and needs. Current developments in the PC-based simulation have clearly shown that the effective training and assessment of mariners is not confined to just the full mission simulator ashore. Above all, instructors or assessors should be able to understand and apply the following elements:

- the prerequisite skill of students;
- the transferring concept and knowledge;
- the activities that would serve as a follow up to the software program being used;
- the way or method to evaluate students' performance;
- the other materials that might enhance the trainees' skills;
- the knowledge of training needs;
- the right learning atmosphere;
- the ability of identifying the topic areas and task to be performed. (As soon as the particular tasks have been classified, instructors or assessors should be able to observe the performance and criteria to be determined for each task)

CHAPTER 6

SIMULATION TRAINING METHODOLOGY IN OTHER MET ESTABLISHMENTS

It is now generally recognized that the use of simulators to achieve specific training objectives is well incorporated in many maritime education and training establishments. National maritime education and training methods vary from country to country. Well trained, specially skilled and motivated mariners are essential in order to manage and handle modern ships safely and efficiently. The need to improve training and identify new directions to improve the quality, professional competency has to be recognized.

Effective use of simulator tools can be adapted so as to give mariners the essential technical skills and the competence to keep up-to-date with new technology. A high degree of trainee activity and interaction is involved in simulation training. Also, it has been acknowledged in many MET institutions as a tool for improving training results. Since the training rate is automatically adapted to the trainees' abilities, training efficiency might be increased if compared to a conventional classroom situation. A low cost PC based simulator tool might be an effective complement to shore based training.

Research and comparative analysis indicates conclusively that there is a wide variation in the maritime education and training systems in different countries. The length of training and the number of contact hours with trainees in the various subject groups are obvious. One reason for variations in MET systems might be the development of dualism in certification systems introduced by some countries. There is no doubt that using modern technology is the way to solve these variations. The use of simulation tools might result in the standardization of the examination system in various MET institutions. The trainees' competency can be measured against well defined agreed competency standards rather than being compared to the achievement of others.

It is generally believed that simulation is a very effective tool that helps not only the transfer of knowledge and skills through training but also provides an effective method of assessing competence. However, Waters and Muirhead claim the following:

> where simulators are used for the acquisition of prescribed skill requirements or accomplishment of prescribed tasks, their use should be subject to compliance with approved performance standards developed against clearly defined objectives.
>
> (Water and Muirhead, 1995 : 79)

It has been accepted that the fundamental approach to the progresses of maritime and environmental safety lies in strengthening the education and training of all personnel involved in maritime industries. The various MET institutions have created their individual training programs to achieve or exceed the specific training objectives by the most cost-effective media.

Some selected simulation training methodology in MET establishments will be presented.

United States

In the United States, the Computer Aided Operation Research Facility (CAORF) has been involved in a Training and Licensing Project which is jointly funded by the U.S. Coast Guard and the Maritime Administration. The judgment of the adapted purpose of simulators in the maritime training and licensing procedure is the overall aim of the project. USCG approval will be required for simulator training programs offered by centers in the USA. Cadet training and education at the United States Merchant Marine Academy employs the traditional form of mixing formal classroom instruction and seagoing training. There are four general areas that the prospective watch officers have to study. These are Navigation, Colregs, Marine Electronics, Seamanship and Shiphandling. Computer aided instruction and simulators have been utilized to some extent in all these fields. Cadets are allowed to work with charts, laying out dead reckoning tracks and taking visual bearings and plotting by utilizing computer simulation. A course in intermediate navigation has to be taken at the United States Merchant Marine Academy (USMMA) after a navigation sea project aboard ship is completed. During the third year of study, a second sea project is to be completed. The navigation curriculum is completed with a course in advanced navigation and preparation for the third mates license exam. A bridge simulation course is provided in the last year of study. It seems that a solid foundation in Navigation, Colregs, Marine electronics, Seamanship and Shiphandling has been acquired by the end of the four year period of training and education.

It appears that courses provided in simulation training for the experienced officer are more straight forward. Courses commonly offered to officers are in one of three areas such as Bridge Management and Teamwork, Seamanship and Shiphandling and Certification. It is said to be a very task specific course.

Licensing of professional mariners in the United States has been based on sea time and the successful completion of a written multiple-choice examination. The USCG has approved a new license examination option for the Master(ocean, any gross tons) license. It can be said that a performance assessment on a bridge simulator in combination with a written examination has been established. SIMSHIP CORPORATION for the RTM STAR Center (in Dania, Florida) has developed the Master Level Proficiency Course (MLPC). The written examination sections which are unsuitable for assessment via simulation are drawn from the USCG's deck officer examination database. Requirements for a license candidate to demonstrate the ability to perform under operational conditions have not yet been laid down.

Sweden

There are two different systems of education and training leading up to the Master Mariners in Sweden. In the old system, every student had to have at least 24 months experience of seagoing service before studying at the academy. It is implied that the student might obtain a Mate's certificate after studying for two years at the academy. The student achieved a Master's certificate of competency after studying for three years at the academy.

There is no entry requirements regarding seagoing service for studying in the new system. Instead, a student has to study at the academy for four years to obtain

Master's certificate of competency. Experiences will be obtained from different seagoing vessels during the additional year. A student has to perform regularly this practice in the different periods during the four years.

Each academic year is divided into four period and a periods contains 8 weeks of studies. In the second period, basic radar navigation in a simulator has to be studied. The instructor determines the exercise area. Echo sounders, Decca Navigators in addition to speed logs and compasses are allowed to be used in the same exercise. The length of exercise is normally 3-4 hours. Radar plotting and basic radar theory have to be studied in period two. Practical training in the simulator will be started as soon as the students have received adequate knowledge in radar plotting. The length of training time in simulation training and basic radar plotting is 14 hours per student. The bridge training course, which is completely directed to the level of watchkeeping officer in simulator training, is the main theme and will coordinate subjects such as navigation, seamanship and communication. Total time for bridge training course is 29 hours for each student.

ARPA theory and practice, and ship handling theory with some practice are included in the period one of year two. Total time in the simulator training is 14 hours. The time allocated for ARPA-exercises will normally be 11 hours and the remaining 3 hours is for ship handling exercises. Total time in simulator for the second period of year two is 19 hours per student. In the second period, continuation of the bridge training course from the previous year has to be learnt. The practical ARPA training will continue.

Analyses of accidents and narrow escape at sea are included in the bridge training course directed towards the Master's level has to be learnt in the year three. The length of the exercises is 4 hours.

The seamanship course in year three is divided into four parts:

1. Advanced radar navigation in inshore and archipelago areas;
2. Ship handling including harbour manoeuvering with wind and current effects. Tugboat assistance compulsory;
3. ship manoeuvring data;
4. repetition of basic radar navigation with radar equipment in the status head up and ARPA not available.

The length of training time is 16 hours per student for seamanship course.
The following additional simulator courses are offered by the academy:

1. ARPA;
2. 'Competence-Refresher';
3. GOC;
4. Bridge Routines;
5. 'Controlled Navigation', Basic;
6. 'Controlled Navigation', Advanced;
7. Ships Manoeuvring, Basic;
8. Ship Manoeuvring, Advanced.

Russia

The radar simulator was developed in the Far Eastern State Marine Academy (FESMA) in 1957. This simulator was designed for training cadets on radar of two active ships passing in the open sea.

Early in the 80s FESMA started to work on the marine navigation simulator for individual/group training cadets in chart plotting and ship's position control. Current, the ship's course and speed, visual bearing and radio bearings of different landmarks and radar coordinates of objects and oncoming ships can be provided by the navigation simulator. Konovalov (1992, page 32.3) believes that during the watch underway it is more important for the navigator to analyze the received information and use it properly for navigation of the ship than to train methods in taking readings off the devices producing this information.

Different cadet's experience and different objectives while executing particular tasks are implied by training methods of simulators. Special training at the training centers of the shipping companies may have been provided to the navigators working on the ships bound for new areas. The main users of radar simulators are shipping transport and fishery companies.

Programs and exercises for training cadets are complied in accordance with the IMO recommendations. 'Ship handling', 'Navigation' and 'Radar and ARPA' courses are offered by the academy. Analysis of training result and its evaluation is executed by using a projector and video equipment.

China

Training courses on radar and navigation simulators for captains, deck officers, pilots and cadets of maritime institutions have been offered by the Chinese maritime institutions since 1981.

Quangen (1992, page 1.13) has describes how Masters and officers have to be trained on radar simulators in order to comply with the relevant maritime safety regulations and conventions made by IMO. Jingson and Fengchen (1992, page 16.1) suggest that one aim of simulator training is to allow the students to acquire skill in collision avoidance. And they also assume that the typical navigator's behavior should be taken as the standard by which to examine the students. Some academic exchanges and seminars for maritime training on radar simulators have been organized to assist maritime education and training work and raise the quality levels of radar and navigation simulator training courses in the Chinese maritime institutions.

The following courses on radar, and navigation simulators courses are offered:

1. Radar Observation and Plotting;
2. Proper Operation of ARPAs;
3. VHF communications;
4. Safety Navigation in Narrow Channels;
5. Ship Manoeuvering tests.

6.1 Other types of simulation

There are many different types of simulators according to their purpose and function, type, size, capabilities and limitations.

It has been learnt that the Federal Aviation Administration has done a great deal to standardize simulators. Four levels of simulator approval have been declared by the FAA such as Phase I, Phase II, Phase IIA and Phase III.

In marine industries, the level of marine simulators might be categorized depending on the features it has as follows:

Category I:	a full-mission simulator
Category II:	a multi-task simulator
Category III:	a part-task simulator
Category IV:	a single-task simulator

6.1.1 Full mission simulation

A full mission simulator consists of some combination of interactive full-bridge simulators and engine room simulators. This type of simulator can be utilized especially for ship-handling, watchkeeping and bridge management training. It is equipped with real bridge equipment and usually has a wide field of view. Communication among members of a ship's team can be performed effectively. Capability of simulating a total environment, including capability for advanced manoeuvering and training and pilotage training in restricted waterways can be achieved through the use of this kind of simulation. Trainees can demonstrate the capability to interpret and make full use of ship's a manoeuvering data. Trainees can determine 'safe speed' under a variety of operational conditions. The ability in optimum use of all navigational aids obtainable and awareness of their capabilities and limitations can be ascertained.

6.1.2 Part-task simulation

A part-task simulator/trainer, such as a radar simulator that produces a very high fidelity simulation with realistic maneouvring and environment effects, but it does not represent the full order of bridge equipment.

Some of the skills required to operate a piece of complex equipment might be achieved by using part-task simulation. If precise manipulative skills are to be involved, it may be necessary to connect some of the actual equipment controls to the computer. A past-task simulator would have the capability to examine the student in a dynamic atmosphere at a cost below that of a full-task simulator.

It is impossible to demonstrate the ability to maintain a good look out. Trainees are unable to monitor internal and external situations for potential hazardous situations. It is possible to demonstrate competency to maintain a radar plot of multiple contacts simultaneously by manual plotting or use of ARPA, and to appraise potential risk of collision.

This simulation is capable of simulating an environment for limited navigation and collision avoidance training. Simplified mathematical models are usually used when developing this simulation.

6.1.3 Comparisons and differences

A 'full-mission' simulator is the most expensive. It has highly sophisticated visual systems. It allows trainees to demonstrate the ability to monitor all navigation equipment and ensure that they are functioning properly. Also, trainees will be able to recognize situations which require the master to be called and to call the master in ample time. Trainees might experience as closely as the real life environment during training exercise.

A 'part-task' simulator has no visual systems and limited navigation instrumentation is accessible. However this type of simulator costs less than a 'full-mission' simulator depending on the features it has. It can produce high fidelity simulation with realistic manoeuvering and environmental effects. As far as ship handling is concerned, it's performance lags behind a 'full-mission' simulator.

A 'single-task'(desk-top) simulator is usually built with a personal computer as the basis. These type of training devices present information graphically and without simulating real equipment. It utilizes computer graphics to simulate particular instruments, or to simulate a limited navigation/manoeuvering environment with bird-eye view. It offers limited training options. But it is the cheapest of the all types of simulation and it might cost a fraction of the price of the above mentioned simulators. This kind of simulation would not present the trainees with a life-size bridge. Simulated vessel controls would be the keyboard or mouse. However, the PC simulation units would take up less space, be portable, and cost less than a full-task simulator. Recent advances in computers offer PC-based systems the potential to process a realistic exam scenario.

To sum up, the choice of marine simulators will depend on training needs and designed objectives.

CHAPTER 7

Conclusions and recommendations

7.1 Conclusions

With frequent changes of on-board personnel today, it becomes increasingly difficult to monitor training effectively and to maintain accurate and reliable records. But there is a role for modern technology to facilitate these issues. The new emphasis on demonstrating skills, encouragement of simulator-based training and the need to monitor performance and standards achieved on board, as well as shoreside training establishments, opens the way for new technology in training.

A major advantage of computer software training programs today is the ability they offer to structure interactive operational scenarios that not only allow for individual training but also offer the trainer or assessor a built-in recording and evaluation system that can be used to measure the trainee's performance.

The revised STCW Convention will result in a number of important steps to promote safety of life at sea and protection of marine environment by improving and controlling standards of training and certification of seafarers to ensure more consistent standards.

Although the standards of these changes are as yet unknown, they may be expected to have an important consequence for maritime colleges, institutes and training establishments. The degree of these outcomes will depend to a large extent on the efficiency and the quality of the education and training in maritime institutions. The changes will mainly be in the practical aspects of the safety training to ensure skills, competence and ability and will therefore also have an impact on the role of the Administration when they issue certificates.

In this respect the model courses currently being produced by IMO will help. National MET education and training systems vary from country to country. The practical way would be regional standardization and the use of a computer-based question and answer bank that could provide the most benefit.

7.2 Recommendations

Pursuant to the above conclusions, the following recommendations are put forward to indicate the directions that need to be taken in future in order to upgrade the present system and meet the international standards.

- The training should be organized by a pool of dedicated, experienced and trained professionals.

- Adaptable and career minded young people with some technical background for training should be recruited.

- Training should be integrated and aimed at competence rather than just training for knowledge.

- The IMT should be fully outfitted with the essential equipment and back up services to repair and maintain equipment and ensure their readiness for use during training.

- The authority concerned should try to convince the shipowners and manning agents to give direct financial support to training institution by providing training aids and equipment as necessary.

- PC based simulators should be utilized as onboard training tools on the government shipping line.

- A full on-board training program should be formulated based on projects and experiences supported by PC based simulator tools and other audio-visual materials.

Thousands of seafarers today need to be trained and upgraded to meet demand in the Union of Myanmar. On the whole it can be seen that the means to achieve effective maritime training is simulation, interaction and self-paced learning. An effective complement to shore base training will be computer based simulation training. Every maritime institution with lack of resources and funds will be able to implement such training. A PC based simulator tool is a realistic alternative to reaching new standards and levels of competence among crews in the maritime industry of the Union of Myanmar.

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Appendix 1

The courses offered by the IMT

(a) Refresher Courses

1. Third Mate (Foreign-Going)	2 months
2. Second Mate (Foreign-Going)	6 months
3. 1st Mate (Foreign-Going)	6 months
4. Master (Foreign-Going)	6 months
5. 1st Mate (Home-Trade)	6 months
6. Master (Home-Trade)	6 months
7. Third Engineer (Foreign-Going)	1 month
8. M.O.T Second Class (Part A/B)	6 months
9. MOT First Class (Part A/B)	6 months

(b) Short Courses (I.M.O Model Courses)

1. Radar Simulator course	1 week
2. Radar Observer course	2 weeks
3. Automatic Radar Plotting Aids	1 week
4. Electronic Navigation Aids	3 weeks
5. Basic computer course	5 weeks
6. Survival at Sea Course	2 weeks
7. Automation and Instrumentation	1 week
8. Ship's Captain medical Course	1 month
9. Tanker Familiarization Course	1 week
10. Advanced Training Program on Oil tanker Operations Course	2 weeks
11. Advanced Training Program on Chemical tanker Operations Course	2 weeks
12. Electronic Course	130 hours
13. English Course for Mariners	30 hours
14. Hazardous Cargo Training	2 weeks
15. Instructor Course	22 days
16. First Aid Course	2 weeks

(c) Seaman Course

1. Seagoing Basic Seaman Course	3 months
2. Inland Basic Seaman Course	3 months

(d) Cadet Course

Mercantile Marine Cadet Course	1 Year

Appendix 2

The following figure shows the "CPA-TCPA" indication as the cause of sound alarm on the radar display

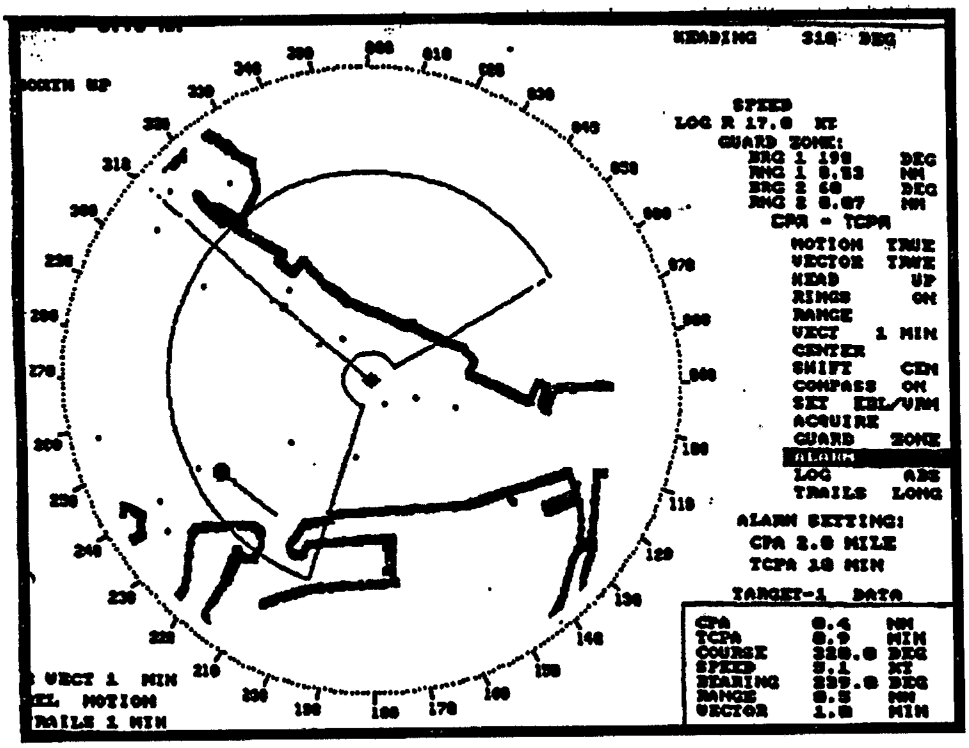

Figure: A2.1
source : NAVI-TRAINER

The following illustration shows a typical view through the forward window in full day and unrestricted visibility.

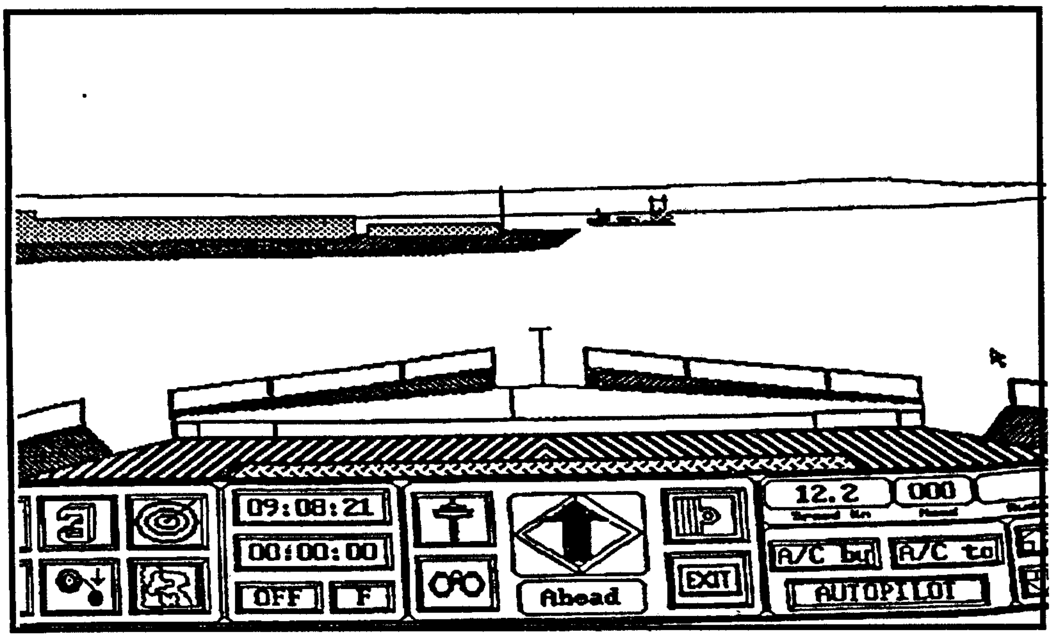

Figure: A3.1
Source: OOW

The daylight view

Condition: zin

Appendix 4

Date: 9th October, 1996 Time: 22:48

Voyage No.: From: To:

DISPLACEMENT SUMMARY:

	%	S.G.	STOW FACT	WEIGHT(t)	LCG(m)	KG(m)	FSM
Hold 1 Iron Ore	100		2.0000	4,735.4	70.39	11.88	
Hold 2 Iron Ore	100		2.0000	5,293.0	42.59	11.57	
Hold 3 Iron Ore	100		2.0000	5,293.0	13.79	11.57	
Hold 4 Iron Ore	100		2.0000	5,293.0	-15.01	11.57	
Hold 5 Iron Ore	100		2.0000	4,442.0	-42.74	12.69	
CARGO IN HOLDS				25,056.4	14.46	11.83	
Iron Ore	25,056 t.						
1F SWBT (P)				0.0			
1F SWBT (S)				0.0			
1A SWBT (P)	86	1.025		1,000.0	63.51	8.63	796
1A SWBT (S)	86	1.025		1,000.0	63.51	8.63	796
2F SWBT (P)	95	1.025		1,200.0	49.38	9.09	837
2F SWBT (S)	95	1.025		1,200.0	49.38	9.09	837
2A SWBT (P)	94	1.025		1,200.0	35.00	8.99	838
2A SWBT (S)	94	1.025		1,200.0	35.00	8.99	838
3F SWBT (P)	94	1.025		1,200.0	20.60	8.99	838
3F SWBT (S)	94	1.025		1,200.0	20.60	8.99	838
3A SWBT (P)	94	1.025		1,200.0	6.20	8.99	838
3A SWBT (S)	94	1.025		1,200.0	6.20	8.99	838
4F SWBT (P)	94	1.025		1,200.0	-8.20	9.01	838
4F SWBT (S)	94	1.025		1,200.0	-8.20	9.01	838
4A SWBT (P)	96	1.025		1,200.0	-22.56	9.29	838
4A SWBT (S)	96	1.025		1,200.0	-22.56	9.29	838
5F SWBT (P)	98	1.025		1,200.0	-36.97	9.93	838
5F SWBT (S)	98	1.025		1,200.0	-36.97	9.93	838
5A SWBT (P)	87	1.025		1,000.0	-51.17	9.99	837
5A SWBT (S)	87	1.025		1,000.0	-51.17	9.99	837
FPT				0.0			
1 DBWBT (C)				0.0			
2 DBWBT (C)				0.0			
3 DBWBT (C)				0.0			
4 DBWBT (C)				0.0			
5 DBWBT (C)				0.0			
APT				0.0			
BALLAST	61%			20,800.0	6.20	9.21	14996

Table A4.1: Example of Bulk Carrier condition of loading : Mariner Software

DISPLACEMENT SUMMARY continued:

	%	S.G.	WEIGHT(t)	LCG(m)	KG(m)	FSM
FWT (P)	97	1.000	90.0	-86.57	17.33	109
FWT (S)	97	1.000	90.0	-86.57	17.33	109
CFWT (P)			0.0			
CFWT (S)			0.0			
WATER	30%		180.0	-86.57	17.33	218
FOT (P)	50	0.990	300.0	-60.18	7.47	541
FOT (S)	44	0.990	250.0	-60.18	6.60	541
FO Set (P)	96	0.990	80.0	-63.44	14.16	9
FO Srv (P)	96	0.990	70.0	-63.44	14.16	6
FUEL	53%		700.0	-60.88	8.59	1097
ER DOT (P)	99	0.900	100.0	-84.62	11.51	144
ER DOT (S)	99	0.900	100.0	-84.62	11.51	144
MDO Srv (P)			0.0			
DIESEL	87%		200.0	-84.62	11.51	288
LOST (C)	47	0.900	10.0	-74.92	0.84	13
LO Str (P)	51	0.900	10.0	-69.39	16.39	3
LO Set (P)			0.0			
Cyc LO (P)			0.0			
LUB OIL	25%		20.0	-72.16	8.61	16
CWT			0.0			
Oily Bilge			0.0			
Bilge Hold			0.0			
FOOFT (P)			0.0			
Sludge (P)			0.0			
MINOR TANKS	0%		0.0			
DWT Constant			185.3	-38.43	10.04	
EXTRAS			185.3	-38.43	10.04	
Total deadweight			47,141.6	8.65	10.64	16615
Lightship			12,170.0	-10.59	10.65	
DISPLACEMENT			59,311.6	4.70	10.64	16615

Table A4.2: Example of Bulk Carrier condition of loading : Mariner Software

Date: 9th October, 1996 **Appendix 4** Time: 21:41

FLOTATION:		
	Seawater s.g.	1.025
	Mean draft amidships	11.43 m.
	Trim between marks	1.56 m.
	Draft at fwd marks	10.66 m.
	Draft at aft marks	12.21 m.

STABILITY STATUS:		ACTUAL	IMO CRITERIA
	GM (fluid)	2.65 m.	0.15 m.
	Area to 30°	24.05 m.°	3.15 m.°
	Area to 40°	44.10 m.°	5.16 m.°
	Area 30 to 40°	20.05 m.°	1.72 m.°
	Max. GZ is	2.17 m.	0.20 m.
	at an angle of	41.72°	>= 30°
	Flooding Angle (Θf)	>60°	
	KGf	10.92 m.	11.90 m.

SHEAR FORCES: Max. = 2231 t. at Fr. 210

Location	Actual t.	Seagoing Allowed t.	%	Harbour Allowed t.	%
Bhd. 48	1804	4290	42.1	5040	35.8
Fr. 66	1889	8340	22.7	9100	20.8
Bhd. 84	1439	8620	16.7	9300	15.5
Fr. 102	954	8950	10.7	9500	10.0
Bhd. 120	475	8950	5.3	9530	5.0
Fr. 138	83	8950	0.9	9530	0.9
Bhd. 156	622	8590	7.2	9270	6.7
Fr. 174	1213	8120	14.9	8950	13.6
Bhd. 192	1869	8120	23.0	8950	20.9
Fr. 210	2231	8410	26.5	9150	24.4
Bhd. 230	737	4880	15.1	5160	14.3

BENDING MOMENTS - not HC/E: Max. = -91912 t.m. at 11.5m. fwd.

Location	Actual t.m.	Seagoing Allowed t.m.	%	Harbour Allowed t.m.	%
Bhd. 48	-12316	-91100	13.5	-119900	10.3
Fr. 66	-38468	-108100	35.6	-147600	26.1
Bhd. 84	-63530	-114500	55.5	-164800	38.5
Fr. 102	-79268	-114700	69.1	-172600	45.9
Bhd. 120	-89504	-114700	78.0	-172600	51.9
Fr. 138	-91845	-114700	80.1	-172600	53.2
Bhd. 156	-87499	-114700	76.3	-172600	50.7
Fr. 174	-74058	-110500	67.0	-157400	47.1
Bhd. 192	-53216	-93500	56.9	-128000	41.6
Fr. 210	-21657	-76500	28.3	-98700	21.9
Bhd. 230	-1629	-57600	2.8	-66200	2.5

Table A4.3: Example of Bulk Carrier condition of loading : Mariner Software