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A review and evaluation of developments in marine simulation training and assessment and impact of such change on maritime education and training in Fiji

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A REVIEW AND EVALUATION OF DEVELOPMENTS IN MARINE SIMULATION TRAINING AND ASSESSMENT AND THE IMPACT OF SUCH CHANGE ON MARITIME EDUCATION AND TRAINING IN FIJI

BY
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FIJI

A dissertation submitted to the World Maritime University in partial fulfilment of the requirements for the award of the degree of Master of Science in Maritime Education and Training (Nautical).

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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 on me.

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

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ABSTRACT

The Thesis is a study of current marine simulation technology, and of the historical and current developments in training seafarers through the use of simulation techniques.

The range of marine simulation systems is vast, and a brief look is taken at the design, categorization and definition of the systems, with special emphasis on the significance in classifying this equipment.

The reasons for utilizing simulation training techniques are examined, taking into account the inadequacy of traditional training methods in the rapid technological changes that have taken place.

Traditional and technological training systems are evaluated and compared. Simulation training methodologies used in some selected training establishments are discussed. The use of marine simulators as an assessment tool and its effectiveness in the training context are investigated.

Additionally, a brief look is also taken in identifying the present training needs in terms of shiphandling operations, considering the concerns of various International bodies such as the International Maritime Organization (IMO), the International Marine Simulation Forum (IMSF) and, the current revision of the Standards of Training, Certification and Watchkeeping for seafarers (STCW) regarding simulation training.

The results from this research project have led to the

identification of simulation training equipment considered appropriate to meet the training needs in the Maritime Education and Training System in Fiji. In addition, proposed plans for various simulation training programmes are devised and the impact of implementing such a development in Fiji are discussed.

The concluding chapters, inter-alia, discuss the adequacy of using simulators as a training tool and, the significance of educating and training simulation instructors. A number of recommendations are made concerning the acquisition of equipment and on the role of instructors.

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LIST OF ABBREVIATIONS

AMC	Australian Maritime College.
ARPA	Automatic Radar Plotting Aid.
CAORF	Computer Aided Operation Research Facility.
CGI	Computer Generated Imagery.
CMS	Centre for Marine Simulation.
DWT	Deadweight Tonnes.
DoD	Department of Defence.
DF	Direction Finder.
FIT	Fiji Institute of Technology.
FMB	Fiji Marine Board.
FOV	Field of View.
GMDSS	Global Maritime Distress Safety System.
GPS	Global Positioning System.
GSP	Graphic Signal Processor.
JICA	Japan International Corporation Assistance.
KAE	Krupp-Atlas Electronic.
IMSF	International Marine Simulation Forum.
IMO	International Maritime Organization.
INSLC	International Navigation Simulator Lecturers' Conference.
ISWG	Intersessional Working Group.
MARAD	Marine Administration.
MARSIM	International Conference on Marine Simulation.
MET	Maritime Education and Training.
MSC	Maritime Safety Committee.
MF	Medium Frequency.
MOB	Man Overboard.
OOW	Officer of the Watch.
PC	Personal Computer.
RAM	Random Access Memory.
RT	Radio Telephone.
SAR	Search and Rescue.
SASI	Safety at Sea International.

SIMON	Situation Monitoring System.
SMS	School of Maritime Studies.
SSPA	Swedish State Experimental Simulator.
STCW	Standards of Training, Certification and Watchkeeping.
STW	Standards of Training and Watchkeeping.
SUSAN	Shipoperation and Simulation Facility.
UK	United Kingdom.
USCG	United States Coast Guard
USA	United States of America.
VHF	Very High Frequency (Radio Communication).
VLCC	Very Large Crude Carrier.
VTS	Vessel Traffic Services.
WMU	World Maritime University.

CHAPTER 1

INTRODUCTION

1.1 The simulator: A preview

The progress of development in the world of marine simulator which now exists has shown an enormous amount of change. Not only the technical possibilities have been improved, but also the insights into the possibilities of applications of simulators and, simulation models have been changed by simple experience and by research.

Radar simulators initially came into existence as navigation simulators incorporating all navigational equipment and communication systems used on a ship's bridge. This training equipment lacked the essential element of a visual scene, however, the equipment could be seen to be an effective and efficient part task trainer.

In recent years, however, navigation simulators have been acquired with a visual scene on at least one student station. These have been commonly called "radar simulators with visuals" and have extended the role of this simulator into that of the shiphandling simulator.

The advance in technology has also shown the development of a low cost shiphandling simulator utilizing compatible 386/486 personal computer (PC) with graphic signal processor (GSP), designed to support shiphandling training and research applications.

1.2 Aims

The system technology, in terms of marine simulators or any sophisticated instrument for that matter, is very complex and difficult to comprehend, unless one has the time and opportunity to make a proper and in-depth study of the system and, how the system technology works and is applied.

This project does not intend to make the author an expert in marine simulation system technology, however, the aims are to provide an understanding of the system development, to be familiar with the existing latest state of knowledge and to grasp the fundamental principles of how the systems are being practically applied to enhance the training of seafarers.

1.3 Background and Objectives

The Fiji school of maritime studies (SMS) has been in existence for the past two decades. In the early eighties, the school was shifted to its new complex at Laucala Bay where it is now permanently located overlooking the Bay waterfront. The school is still in its developing stages in terms of staffing and training equipment.

In the meantime the school has no simulation equipment to train its ever increasing number of seafarers. However, two radars have been provided to train sea-going officers in the radar observer course, but this is considered inappropriate due to the radars being stationary which gives the students no perception of the interactions of ships.

The major objective of this project is to take a look into the existing simulation technology in order to closely understand the system, to identify the appropriate simulation equipment and to devise various simulation training programs for the training of seafarers in Fiji. The provisions deduced from this research project can be used by the Ministry of Education, Science and Technology as a guideline to ensure that the equipment is acquired in order to fulfill the International Convention on Standards of Training, Certification and Watchkeeping for seafarers (STCW).

1.4 Scope

It is not intended to make any in-depth study of the technical details of the marine simulation system and it is out of the scope of this project. However investigation into the system is mainly based on what the existing technology offers.

The project consists of four core chapters in which various aspects of marine simulation systems have been examined. The justification in the use of the system for training applications is discussed and the needs and concern of the maritime community of the training of seafarers in the ever increasing technology are identified. The impact of the application of simulation in the Fiji MET system is discussed.

The last chapter of the project provides a final conclusion which summarizes the justification for the use of the system, and the recommendations which have to be pursued for the procurement of training equipment in Fiji MET and for the region.

CHAPTER 2

THE HISTORY OF SIMULATION TRAINING DEVELOPMENT AND CURRENT TECHNOLOGY

2.1 The History of Simulation Training

Since before World War Two, Link-Trainers and Flight Simulators have been in existence with the Royal Air Force and Commercial Airlines. The characteristics of these simulators were mechanical in nature and gradually, through the electromechanical stage, developed into sophisticated electronic devices complemented by hydraulic machinery of great complexity.

In the Modern Maritime World, the concept of simulator-based training is not new. In the early fifties, simulators for navigators were first mentioned. Shortly after, the first marine simulator was built and introduced in the form of a Bridge Simulator. The device was nothing more than a radar target injector used for teaching basic radar skills.

The real reason for the introduction of simulators, which is so different to the conventional training carried out in navigation schools, was the application of radar in merchant ships after the war, an instrument so revolutionary for navigating officers that adaptation was very difficult.

It was not so much the actual navigation i.e. getting a proper fix, but the avoidance of collision with other ships, ironically called "targets" during reduced visibility which created difficulties. Since the fifties, the development of simulator technology for training and research purposes has progressed considerably.

2.1.1 Simulation Training Development in The Maritime Industry

Over the last four decades, the shipping industry has experienced a significant change in technology in terms not only of ship size, design and speed, but also in the equipment used on board. A variety of sophisticated instrumentation systems has been incorporated into both the navigation and engine room department. Due to the increasing complexity of these technological changes, a very high level of competence and skills is demanded.

Why all these changes one would ask ? The simple answer to this question is competitiveness and profit making for the ship owner. As the productivity of shipping has increased over the years, so have the risks associated with shipping, the difficulty of operations and requisite level of mariner skill required and, also the potential damage and cost of accidents. History has shown that the global maritime industry is lagging behind in the use of computer simulation for training, compared with the Aviation industry.

Due to the vast change in technology, concern was and, still is, growing in the maritime community and, as a result, the growth in the use of simulators for training became apparent.

Over the years the maritime industry has experienced various types of maritime accident which has led to substantial financial loss, catastrophic loss of life and damage to the marine environment. In the investigations into the cause of these accidents, it was usually held that, seventy-five to eighty percent of the contributory causes resulted from human error. For this reason considerable emphasis has been echoed to all segments of the maritime industry to improve mariner proficiency in the use of computer simulation for training.

This emphasis has resulted in the accelerated development and implementation of simulators for training in most maritime training establishments around the world.

2.2 Definition and Categorization of Simulators

A great number of training institutions around the world today make use of the simulator as a training medium. Why is this so ? This may be due to a lack of knowledge in the maritime administration and training institution, and also may be due to a lack of a definition and classification of this equipment.

However, a great deal of thought has been given recently to the categorization of this equipment. It is curious to note as to why there is not a generally accepted system in place. The general conclusion to this is that, there appears to be a lack of agreement not only in defining types of ship simulator, but also on what each type can accomplish.

The need for a definition and classification system is an essential element to the whole process of acquiring these training tools, especially so in the case of developing countries. The development of a simulator classification system would be of great value, not only to the developing countries, but to all concerned who are in the planning process of acquiring these materials.

In June 1992, the International Maritime Organization (IMO) had difficulty in obtaining information about training simulators from many administrations, as reflected by the low response to a questionnaire circulated to all members. This outcome occurred apparently because marine administrations generally were not always knowledgeable about training simulators.

In 1994, the need for a categorization system is greater than ever, with marine administrations considering recommendations and regulations, as well as ship managers considering advantages for their business. Simulator customers expect and deserve a clear description of a facility and what it can do. Without a precise and concise categorization system uncertainties to the potential user would be created.

The recent sub-committee on Standards of Training and Watchkeeping - Intersessional Working Group (ISWG) report, regarding the "COMPREHENSIVE REVIEW OF THE 1978 STCW CONVENTION AND PREPARATION OF RELATED CONFERENCE RESOLUTION" STW 25/3/13 of September 1993, submitted proposals to adopt the following definition and categorization of simulators:

(a) Definition

Simulation: includes any shiphandling, radar and navigation, cargo, propulsion, or other ship's system simulator that provides a realistic imitation of that system's operating parameters in real time and has an interface suitable for interactive use by a human operator or operators. Simulation of specific shipboard functions may be accomplished with specially designed software programs operating on general purpose computer hardware.

(b) Categories

Full Mission Simulator: means an instrument or facility which is capable of simulating a total environment e.g. the sophisticated shiphandling simulators used for port development studies, advanced manoeuvring and pilot training and full mission engine room, cargo and docking simulators come into this category.

Hybrid simulator: means an instrument or facility which is capable of simulating a limited environment, e.g. navigation simulator with limited visual field of view and limited shiphandling capability.

Part Task Simulator: means an instrument or facility which is capable of simulating a single ship's system of a limited combination of tasks relating to a system, e.g. radar/navigation blind pilotage simulators, cargo and ballast control simulators, including networked interactive personal-computer-based systems.

Desktop Personal-Computer-based Simulator: means a personal computer using programs designed to simulate a single ship's system or set of operations in real time for interactive use by an individual.

The objective of developing a categorization system is to enable a marine industry person without a simulator background to recognize and understand the appearance and purpose of different types or levels of simulators. The above definition and categorization system, it is hoped, will be generally agreed upon by the maritime community.

2.3 Types of Simulators

The development of marine simulators has reached a high degree of sophistication and complexity, including diversity in size and capability. These range from relatively simple part task trainers, used for individual skill training, to large units used for team training and needing many staff for their operation.

It is extremely important that, whatever the level of sophistication is, the technology should provide proven assistance and reliability. To be effective, it must incorporate the needs, capabilities and the limitation of the human operator. A list of simulation training equipment is provided in APPENDIX A.

2.4 Current Technology

The marine simulator system uses modern computer techniques to allow simulation at all stages for training as well as for research work. Several different technologies have been used in the past to generate the panoramic views out of the windows, of which some are still currently being used.

The system techniques utilize fully validated mathematical models, that represent the latest state of knowledge and provide accurate ship motion. Two distinct classifications of visual systems are recognized. These are the nocturnal visual system and the daylight visual system.

2.4.1 Nocturnal Visual System

Various techniques are used in this type of visual system. Simulators with classical light source projection systems use techniques whereby the picture is projected on to a screen. The position of the projection system and thus the image on the screen, depend on the position and viewing direction of the ship (object).

Other techniques use lightpoints, which are projected on to a screen. In this system, a ship is represented by a specific cluster of lightpoints, or pattern of lights, which depicts the navigation lights i.e. masthead lights, side lights and stern lights. From the position of different coloured lights, information can be deduced about the moving direction of the ship.

The computer controlled spot projectors of the system, form the scene with a resolution of at least two minutes of arc. The pattern of lights accurately represent, in both colour and intensity, objects as seen from a darkened bridge on a completely dark night. Other objects such as port facilities, landmass, buoys and coastlines are also represented by means of lightpoints or pattern of lights. In these systems, usually no profile or silhouette of the objects is visible.

2.4.2 Daylight Visual System

There are several different versions of the daylight system. One type of system used large model boards. The model board had an accurate scale model of the environment. On this board, a television video camera moved according to the data from the simulation computer.

The television picture represented the environment as seen by the camera and was projected by several video projectors, depending on the horizontal field of view, on to a large screen or on to a television screen. The movements of the simulated vessel controlled the position and viewing direction of the camera on the model board.

This type of visual has been used to generate a nocturnal scene and has not been very successful, which is in part due to the limited brightness range of the raster and the restricted resolution of the video generated light spot.

Another system which has been used is a continuous film device. While this provides excellent resolution, preparing the data base and finally projecting the finished product is a difficult procedure. This system has become outmoded, as technology concentrates on a projection technique that will provide a bright resolution picture.

The aforementioned techniques have many advantages in both design and in meeting particular training objectives. However, these visual techniques suffer some inflexibility, which calls for an improvement of the system technology. Attempts were made by the USA Maritime Administration (MARAD), to develop design specifications that would fulfill the following characteristics:

(i) Full colour
(ii) At least six different traffic ship in visual scene
(iii) Day and Night operation
(iv) At least 240 degrees Azimuth
(v) Life size wheel house
(vi) At least 24 degrees vertical field of view
(vii) Radar - 24 ships commercial accuracy

The above characteristics were accepted, but still, there is a lack of objectively validated evidence as to their necessity. The Computer Aided Operations Research Facility (CAORF), at the National Maritime Research Centre, Kings Point, New York, was given the task to determine objectively, the importance of these characteristics for simulators, in terms of research as well as training.

CAORF's investigations of the role of simulators in the training process program, addressed the question of the impact of the simulator characteristics on training effectiveness. The system technology was pursued, various methods and techniques were investigated and, it was finally found that the computer generated imagery (CGI), was the only technique which could solve and fulfil the above mentioned characteristics.

The CGI technique utilizes a video based system which shows a full pictorial display and, can include port facilities, landmass and other ships in all day, night and dusk conditions. For this reason, the CGI technique was selected as the only system capable of providing what was required of an image generated system.

Current ship simulation technology has a very remarkable improvement in that it exceeds the design characteristics previously mentioned. Some ship simulators are capable of producing a horizontal field of view of 360 degrees and up to 40 degrees vertical angle of view.

The realism of the visual system is tremendous, some ship simulators having vibrating motors under the flooring, to simulate the vibration developed by a real ship's engine notably the $12 million facility at the Centre for Marine Simulation (CMS) at St. John's, Newfoundland, Canada. The CMS Ship's Bridge Simulator (built by Norcontrol) is of the CGI type and was commissioned in June 1993. It is mounted on a motion platform which provides dynamic responses to internal and external environmental inputs. The simulator is capable of generating a field of view of 360 degrees.

The majority of marine simulators which are currently in operation and some which are in the construction stages, use the CGI technique. Many simulators of the CGI type have imitated the CAORF approach to simulation techniques but use less expensive, lower fidelity and lower capability projection systems in an attempt to produce cost effective, affordable simulators.

2.4.3 Design and use of systems

Ship simulators have a very wide range of uses. Most of the well established simulation installation facilities around the world, have a dual purpose commitment to training and research. The activities in these establishments may be broadly divided between training and research, although much of the research work is closely associated with software and hardware development.

There is a close link between the two fields of activity. For example, a port design study will be supported by courses in port familiarization for the port operators and, operational strategies developed for the port as a research activity, will be practised as a training course. During these courses, deficiencies in the design may be detected, which will then impact on the developmental activity.

Difficulty of seeing leading marks, or insufficient information to guide ships while turning to make an approach, may be highlighted during a course. For such comments to have validity in the actual port setting, the simulator must provide adequate visual cues for the mariner to respond in the same way as he would aboard ship. During such research exercise, close attention is focussed on the importance of ensuring that adequate cues are given to the mariner.

The essential components of the visual scene may be considered to be:

(a) type
(b) complexity
(c) field of view

(d) screen distance

(a) Type: Depending on the type of simulator required, it is considered to be one of the most critical elements making up the cost of the simulator. A good CGI daylight system may well cost over US $3 million to produce. However, much training work can be perfectly satisfactorily carried out in a nocturnal system, which is less expensive, especially in the area of activities such as passage execution and bridge procedures. The daylight system is required for close quarters work where far more visual cues are needed.

(b) Complexity: Recent studies have concluded that much of the advantage of a daylight scene will be lost if the capacity is too low. Research into the suitability of a CGI simulator for port design work, showed that mariners relied very heavily for their position and speed information cues, on the existence of many informal transits usually at right angles to the path of the ship. These transits do not relate in general to features found on the chart, but may simply be trees, chimneys etc.

It is considered critical for a simulator which is to be used extensively for close quarters work, that the visual scene contains sufficient details for these informal transits to be established. This places certain demands on the capacity of the system. Sea texturing is also considered to be particularly important for determining ships speed, both close to a berth and also in open waters, where other cues may be absent.

(c) Field of view: The cost of the facility will be heavily dependent on the horizontal field of view required and thus the number of channels provided. For close quarters situation, it is obviously necessary for a beam view to be provided. 30 degrees vertical field of view is considered adequate to allow the viewing of the natural passing distance of other ships, passing narrow channels or fairway, or making a berthing manoeuvre.

A limited horizontal field of view of 120 degrees may be adequate for open water navigation, where collision avoidance is of paramount importance. However, it is possible to offset the visual system if required, so that it looks astern for example, but the bridge layout should also be turned round otherwise some confusion may result with inexperienced mariners.

(d) Screen distance: There are two problems which arise with a screen that is too close:

(i) The parallax problem, where the apparent bearing of the ship depends on where the observer is standing.

(ii) The difficulty of using binoculars, which is the mariner's first instinctive reaction on sighting another ship.

It is possible to use binoculars only in a nocturnal simulator. The calculation of the screen distance is a complex balance between brightness, field of view and number of channels.

The Bridge Layout:

A major area of interest in ship simulator design is that of bridge design. The features incorporated will be determined to a very large degree by the predicted uses of the simulator. For many applications, a generic bridge, fitted with a typical range of instrumentation will suffice. However, the intended use of the simulator must be considered to ensure that proper instrumentation and controls are available without overloading the bridge with unnecessary items.

For many applications however, a particular bridge is required to change regularly, for example; from a merchant navy type of bridge to that of a royal navy frigate. This type of requirement places fairly severe constraints on the bridge design. For this to occur, it is considered adequate to have all the equipment in modular fashion, so that it can be removed completely and a variety of interfaces is required so that new equipment may be interchanged without difficulty.

Many of the existing simulators do not use glass in the bridge windows, in order to reduce unwanted reflections. sometimes this is not possible due to noise or the lack of cooling or heating outside the wheelhouse. There are three important points on which to focus when settling on the bridge simulator design.

(i) The impact the layout will have on viewing the visual scene.

(ii) Does the layout relate to the type of vessels to be simulated in the forseeable future ?

(iii) Will the layout support either bridge team or individual training ?

For a daylight simulator, a particular problem is the lighting of the bridge interior to an acceptable level, without swamping the available light from the screen. An elegant solution is to flood the floor with light from waist level louvres.

Instructor Control Area:

It has been held that the layout of the bridge in the visual system is the most important element of the simulator. If this is so, then the very next item in the hierarchy is the Instructor Control Area.

The important feature that must be designed into a training simulator is ease of operation by one instructor. This has to be done without degrading the quality of training.
To be effective, the instructor must have available communications, graphics and data displays that will permit him to interface with the trainees in many modes.

The training exercise usually requires interaction in which the instructor plays a number of different roles. As technologically advanced as the equipment may be, one of the most effective aspects of any simulator is the role played by the instructor.

While involved in this activity, he must also be able to accumulate and evaluate data regarding the trainees' performance. This data should also be available in a `hard copy' form that can be used when debriefing the trainees following an exercise. Controls should be provided in this area so that, when desired to change the exercise parameters, readily simple keyboard commands or push button controls should be provided.

The instructor should be able to alter the characteristics of the simulation, when desired, through data manipulation. A simple example of what might be required is to change an "in ballast" vessel to a "loaded" configuration during a particular exercise.

2.4.4 Blind Pilotage

The blind pilotage simulator, also known as a radar simulator, varies in design and facility layout according to the need of the potential users and customers to meet intended objectives. The design and layout of this system consists of:

(i) Instructor Console

(ii) Briefing and De-briefing room

(iii) Own Ships

(i) Instructor Console:

The instructor's console is extremely important. The instructor should be able, at all stages, to monitor and supervise the exercise, and to interact at appropriate times and to introduce malfunctions, failures and errors of navigational systems installed in own ships.

He should also be able to prepare, plan and play back the exercise. The console has computer digital display showing own ship's and target's course and speeds and, the coordinates for the navigational aids of own ship; an X/Y plotter to show all or selected target track; a radar display which could duplicate any own ship display; an intercom for communicating with own ships and monitoring V.H.F. traffic.

(ii) Briefing and De-briefing room:

A briefing and de-briefing room is also an important element of this system. This room is adjacent to the own ship cubicles of a size adequate to accommodate the required number of students, or a full class room size can be used for instruction before and after each exercise. At the Australian Maritime College (AMC), adequate room space is used for the required intake, in contrast to the full class room size used at the Bremen Polytechnic in Germany, as an example.

(iii) Own Ships:

Most of the training institutions around the world acquired four own ships. However, the International Radar and Navigation Simulator Lecturers Conference (IRNSLC) now the International Navigation Simulator Lecturers' Conference (INSLC), guided by the World Maritime University, is of the opinion that the minimum required is three own ships.

The minimum required performance for a radar simulator set forth by the INSLC should have at least 20-target ships, 16-inches (40 cm) Position Plan Indicator, Automated Radar Plotting Aid (ARPA), digital coastline, Very High Frequency Radio Telephone (VHF/RT), storage and replay and, keyboards for instructors.

Norcontrol of Norway made great strides with their designs and their product (databridge) was ordered by many schools. Some of these radar simulators are equipped with 500 fixed targets, so useful for all kinds of purposes, including the drawing of a coastline and 40 programmable targets.

In addition to own ship's cubicle instrumentation, a comprehensive range of navigational aids such as Sat-Nav, Decca, Loran A & C, Echo-Sounder, Direction Finder, Manual and Automatic Steering and, possibly Navtex is installed, meeting the specifications required by the International Maritime Organization (IMO).

The advance in technology has shown the advent of microcomputer-based design for a cost effective visual system. This system, designed by the Department of Nautical Studies, Hong Kong Polytechnic, acts as an add-on unit to the radar simulator with each own ship having its own visual presentation. Each display terminal has a field of view (FOV) which can be varied as required - `28 - 80 degrees Azimuth and 21 - 60 degrees vertical.'

With the introduction of the visual scene as an add on unit into the blind pilotage system, some doubts are raised in the author's mind. Would this visual add-on qualify the system as a blind pilotage trainer ? The author doesn't think so. This will only defeat the purpose of the blind pilotage simulation.

Although radar simulators were originally designed for training deck officers in collision avoidance, it was found that they could be adapted for many forms of training such as:

(i) Training of pilots.

(ii) Training of Tug Masters.

(iii) Training of hydrofoil and hovercraft in navigating particular ports.

(iv) Training of customs officers to manoeuvre their high speed motorcraft along difficult and dangerous coasts.

(v) Training of lifeboat operators.

Special courses were laid on for Search and Rescue practices and exercises were developed for training of duty officers engaged in Vessel Traffic Services (VTS). Sometimes quite involved exercises had to be devised which combined the training of pilots, V.T.S. duty officers, dock and harbour master. Training in the use of Automated Radar Plotting Aids (ARPA) is incorporated.

The demand for all this training means that radar simulators have had to become much more flexible, i.e. the modelling of manoeuvring characteristics of many different types of vessels, sometimes to be done to a fairly high degree of accuracy if the simulator is used for pilot training, and that, in many cases, additional equipment had to be fitted, such as VHF/RT communication simulators with a variety of channels, fog signal simulators and visual presentation.

In general three levels can be specified:

(i) Basic simulators for the training in collision avoidance and the principles of navigation.

(ii) Simulators which offer additional ARPA training.

(iii) Sophisticated simulators which can be employed for the training in integrated navigational systems, command training and surveying.

2.4.5 PC Simulators

The advance in technology has been shown by the recent introduction of desk-top PC simulators in the maritime industry. The introduction of these simulators is very welcoming and timely to the unfortunate maritime training institution, which is denied the opportunity to acquire full scale simulators because of the high cost involved.

There are several different PC based simulators currently available in the market. These simulators have been designed as low cost training units, directed at a particular level of training. It was never originally intended that they should supersede the full mission radar and ship simulators, but to complement them. Some training establishments in Europe are using these low cost systems for training their personnel due to the high costs of full mission simulators.

Although the PC based simulators are unable to duplicate real life situations, they can be of great value in allowing cadets, particularly in countries where resources are scarce, to practise and refine their basic knowledge and skills. However, they are restricted to a part-task training role.

A PC based simulator would have the following advantages over a full scale ship simulator:

(i) The cost is a fraction of that of the large scale simulators normally found in nautical colleges. This puts the PC based simulator well within the training budgets of the smaller colleges.

(ii) The simulation is capable of running on any 386SX IBM PC or compatible with at least 512K RAM and a graphic capability. Most colleges and training establishments have access to a number of suitable PC's.

(iii) The choice of exercises can be tailored to fit the requirements of the individual student. The exercise can be selected by the student himself or can be specifically configured by the instructor.

(iv) The portability of PC's either onto other compatible machines or on allocated laptops allows students with difficulties to practise in their own time. It is also possible to take a PC based simulator on board.

(v) Full playback facility is being developed that will show a plan view of the exercise. The student or instructor will be able to control the playback in a similar fashion to a video player with forward, reverse and pause facilities. This will allow the user to look at each stage of an encounter in detail and to fully understand the actions of the other vessels involved.

Some of the PC based simulators which are currently available are:

(i) Sisradar - Radar Simulator

(ii) Portsim - Ship Manoeuvring Simulator

(iii) OOW - Rule of the Road Simulator

(i) Sisradar Simulator:

The Sisradar simulation system, has 6 optional upgradeable configurations of sea information systems for radar simulation training. The configuration of the system is entirely up to the potential user's choice, which can be either a remote station or stand alone radar.

The main features of this system are the facilities at each student station which consist of radar controls, Arpa features and the facilities at the instructor's station.

Sisradar also consists of a chart making facility as standard allowing input of depths, buoys and coastlines. The system is user friendly and requires no special equipment. To speed up the operation however, a digitizing tablet may be used as an optional extra.

The chart making facility enables the user to create any part of the world he chooses. The system provides one chart of the English Channel as standard and, the user can create as many charts as required which can be stored away.

(ii) Portsim Simulator:

The portsim ship manoeuvring simulator, produced and developed by SSPA Maritime Consulting AB in Gothenburg, Sweden has a wide range of applications, such as training of ship officers and pilots, investigation and development of safety routines, assessment of risk situations and determination of safety weather windows as well as studies of ports and fairways. This system has met great response from existing and potential users.

The system has a combination of mathematical models and modern PC-based graphics to produce powerful and flexible realism simulation. The simulator is user friendly with all man-machine interfaces completely mouse controlled in which no previous computer experience is required.

A bird's - eye view is shown on the screen of the continuously moving ship together with the surrounding land, port with quay, buildings, buoys and flashing lights etc. All relevant bridge instrumentation data are displayed on the screen.

Portsim system provides four different types of tugs (conventional, thruster midships or aft and Voith Schneider) which can be pre-selected. A maximum of three tugs can be individually operated, with realistic tug forces at varying speed simulated, as well as the interaction between tug and vessel.

The portsim ship manoeuvring simulator consists of three different versions namely:

(a) Portsim A - for real time manoeuvring and shiphandling.

(b) Portsim B - for tug assisted manoeuvres.

(c) Portsim C - for advanced manoeuvring investigation.

(iii) OOW - Rule of The Road Simulator:

The Officer of the Watch rule of the road simulator, produced and developed by PC Maritime, is a powerful three dimensional (3D) simulator, designed to teach all the procedures and strategies for minimizing the risk of collision at sea and, maximizing the student instruction.

The OOW has a unique expert system with a knowledge base of the International Regulation for the Preventing of Collision at Sea. The expert system has two main roles:

(a) It controls the actions of all simulated ships (except Ownship and optionally, rogue vessels) so that instructors can create realistic and truly interactive exercises.

(b) Advises the student who can be allowed to call the expert system during an exercise to get guidance and interpretation of the collision regulations.

The concept is very clever and is matched by a well designed package. Essentially from the watchkeeper's position on the bridge, the student has three dimensional views, ahead, astern, port or starboard. The visualization is available in day, night, dawn and dusk conditions, within the latter, vessels appear in silhouette.

In 1989, PC Maritime won an award from the British

Government to help fund a feasibility study into designing a collision avoidance simulator specifically to run on PC's. In 1993, the Seatrade Award for Safety at Sea was won by PC Maritime for their product "Officer of the Watch" desk-top simulator.

2.5 Conclusion

It is almost half a century now since the inception of marine simulation technology. The progress in technology has reached a very high level of realism, in which one can hardly distinguish the real from the realistic in such equipment. Although, the system technology is high, research is not stagnant, but continues in search for disparity.

The advance in technology has seen multi-million dollar full mission simulators, equipped with full size ship's bridges, complex hydraulic motion bases and stunning visual displays which can faithfully reproduce virtually any combination of vessel, sea state and port facility a client may require.

If we take a look at the other side of the spectrum, PC based simulators have been introduced. The rapid growth of PC microprocessor power and vastly graphics systems, now allow developers to produce marine simulation scenarios that are far more complex and detailed, than any PC based application available just a few years ago.

It is envisaged that the microcomputer will continue its evolution, which will likely offer more capability for less investment in the years to come. However, a very important question arises. Which of these systems is a simulator ? National and International regulators should provide a clear clarification on this issue as few people would argue that seafarers should be trained on a full mission simulator and, equally few would feel comfortable using PC based desk top simulators.

However, full mission simulator producers must ensure that the claims made to potential users truly reflect the capacity of both their technology and their instructional staff. Those promoting the use of PC based desk top system for specific training must be equally careful in determining the limits of this technology and, the impact those limits have on the effectiveness of training.

Faced with new technologies and conflicting claims for the comparative benefits, prospective clients must feel confident that the advice they are given is based on a recognized standard and geared to their needs rather than the producer's business objectives.

CHAPTER 3

A STUDY OF THE SIMULATOR AS A TRAINING TOOL IN THE MET SYSTEM

3.1 Why Simulation ?

Before taking a look into the use of simulators in the MET system it is considered appropriate at this point if we could justify whether the need of simulation training is essential. If we take a close look into the existing shipping world it can obviously be seen that ships are getting larger, faster and more sophisticated.

These ships are, and can be, very difficult to handle and, in order to counter this sophistication, proper training of the human element under simulation technique is considered to be the best alternative. This is one reason, however, there are many more reasons as to why the need of simulation is required.

The high cost involved in running and maintaining training ships is beyond the reasonable doubts of training institutions. The trend of reduced manning of ships and the high level of existing technology all lead to the requirement of simulation training. During recent years particular attention has been given to the safe practical handling of ships and in order to increase safety, a system approach has to be applied and one element of the system is human efficiency.

Several serious casualties involving collisions which led to disastrous results have stirred public opinion and stimulated maritime administration to take action. These accidents occurred due to lack of knowledge and lack of practical know-how by ship officers in the behavioral characteristics of ships. To gain this knowledge and know-how attention has been paid to the use of simulators.

Research has shown that the process of objective training develops more quickly through the use of simulators for skill training. The lessons learned from reviewing the reasons for using simulators in the training process is that it is viable, safer and more cost effective, compared to training on full scale standard operational ships, as might, at first thought, seem preferable and more economical.

Structured training usually involves the use of simulators both for individual and team training. It is universally recognized that for a wide variety of skills the simulator is the most effective of all. Simulation based training has the significant advantage that the rate of skill acquisition can be monitored and measured.

Pace and intensity of training can be suited to trainee capability, any misconceptions and difficulties being revealed and quickly corrected. It has been proven by the USA Navy that simulators provide quality control to training in a way that no other method can achieve.

Hill (1991, 12).

The reasons why simulation training is essential can be summarized as:

(a) training on real ship would involve high risk or danger.

(b) training can be extended into failure and emergency situations without causing damage.

(c) trainee performance can be readily monitored, analysed and assessed.

(d) real ship would incur higher capital cost, operating cost or both.

(e) the repeatability of training exercises is excellent. This cannot be achieved in the real world conditions.

To conclude, referring to the IMO Secretary General's remarks published by Safety at Sea International in the September 1993 issue which states:

> Ten years ago, ship's simulators were regarded as a useful aid to maritime training. Today, they are generally regarded as essential, not least by the IMO...

3.2 Evaluation and comparison of traditional and simulation training methods.

It is obvious that in the traditional training world, knowledge or education is purely gained from classroom instruction. The use of the verbal skill is the main tool, chalk and black/whiteboard, ink-pen and overhead projector are sub-tools to drive home the key points. At the end of the course program it is common practice that students' performance is measured by means of examination whereby their ability is assessed as to how much they have gained from ordinary classroom lectures.

To enhance the transfer of information beyond the channel of verbal communication, various techniques are used such as drawings, function graphs and other illustrations. The medium used to visualize this information again may be black/whiteboard, transparency, slide or paper handouts and perhaps video cassette if available. The highest level of traditional training method is achieved by the use of physical models, either of reduced scale or real size.

The traditional examination method in the area of shiphandling operations is conducted by using wooden models. In this manner, the examiner moves the wooden model on a flat surface with the actual helm and engine manoeuvres likely to be encountered. If the student demonstrates these manoeuvres correctly this may lead the examiner to be satisfied that the student has grasped the fundamental principles of shiphandling.

However, does this mean that the student has the confidence and skills in handling the real world situations ? This question is difficult to answer until the student lays his hands on the job. Therefore the knowledge gained merely serves as an enabling function, it does not guarantee the ability to perform.

On the other end of the spectrum, technological training i.e. the simulation training method, provides the trainees with hands-on exercise, in which they can apply the knowledge gained from the classroom instruction setting. This knowledge is put into practice to test the trainees' competence and practical skills.

Basically, it can be safely said that simulation training is a two way transfer of information, whereby the instructor continuously interacts with the students during the exercise proceedings.

The trainees spend a minimum time in classroom lectures which allows them to use maximum time in the hands-on training using simulators. The simulation training method enables the trainees to build their confidence and to refine their practical skills in some specific areas such as berthing a ship or turning a ship shortround as examples.

In this training system the trainees are briefed before the exercise by the instructor on what will be encountered. On completion of the exercise, a de-briefing session takes place whereby the instructor reveals errors and mistakes the students make on which the trainees can reflect. Simulation training is indeed valuable in that the competence and the practical skills of the trainee can be directly measured as previously mentioned. Any error made by the student during an exercise can be played back and corrected.

By comparing the two systems, it can be seen that in the case of simulation training, a functional approach is being emphasised. Whereby in the non-technological system it is based on knowledge. However, it is appropriate to question whether the traditional training system is justifiable in today's modern shipping. This system can only be considered to suit the ship of sail and paddles. Does the training effort in the traditional manner suit today's ships and, ships of the future ? In the author's opinion, the answer to this question must be a qualified no.

In the September 1993 issue of SASI, a ship master who was trained under the traditional training method spoke of his experiences:

> ...Having never carried out manoeuvres before, I had to rely on what I had learnt in the classroom. This is alright up to a point, but text book ships and text book weather conditions are not always what happens in real life...

It is unfortunate to say that, at the present time, modern ships equipped with sophisticated machinery are manned by personnel who are being trained under the traditional training method, which means that they do not meet the technological demand required of them in the existing sophisticated technological shipping world. Who then are to be blamed for this pitfall ? Certainly not the seafarers themselves.

It is clear that the transition from traditional to technological training is the responsibility of the individual national authority and training institution, to ensure that proper simulation training equipment is acquired and a training program devised, so that seafarers are not denied the opportunity of meeting the required training standards. Richardson postulated as follows:

> Technically the training facilities have to reflect today's shipping structure. Methods and training syllabi require adequate backup by modern technology's simulation and practical operational training units. The old fashioned classroom filled with eager trainees, experienced instructors, chalk

and blackboard is not deemed adequate anymore to meet today's demands. A properly equipped training place will require substantial investments in equipment and facilities, to meet required standards.

Richardson (1989, 147).

3.3 Simulation - How effective ?

It was mentioned in sub-section 3.1 that simulation is recognized worldwide to be the most effective method of training ship personnel but, there appears to exist growing differences of opinion and belief as to the effectiveness of this equipment. However, the pressure to maintain and improve training standards in the face of expensive modern technology has had a declining effect in its use.

Although a few trials and evaluations have been carried out in the training process there is a lack of statistical analysis to illustrate the full proof of the effectiveness of this equipment in the context of training. So how really effective is simulation training ?

From 1967 to 1980, the United States Department of Defence (DoD) conducted fifteen different studies by comparing the effectiveness of maintenance simulators as against the actual equipment trainers. During this period, five different types of simulators were evaluated and one of the findings concluded was that simulators are as effective as the actual equipment trainers.

In 1982 and 1983, the United States Navy undertook an evaluation on the effectiveness of simulator-based training, in relation to the traditional training at sea in visual navigation for junior Navy officers. The report of the study concludes that, these trials demonstrated that simulator-based training in visual navigation and blind pilotage, produces effective learning and skills development and, about eighty percent of the skills were transferred effectively to sea.

In the Netherlands the training of pilots through simulation exercises has been proven in practice to meet their goals. As postulated by Butter in one of his concluding remarks:

> ...The present training has been proven in practice to meet the targets... simulator training is for the pilot a valuable aid in developing his specific know-how and skills to an ever further extent.
>
> Butter (1992, 623).

It is clear and obvious from the above evidence that simulation training is indeed effective. Perhaps the differences in opinion and belief in the effectiveness of this equipment may be subjective rather than objective. By this, it means that subjectively, the equipment may be designed for use in various regimes which could be effective in one area and may not be effective in another. Objectively, the equipment may be designed for a specific training purpose and may prove to be as effective.

3.4 Simulation training methodology in other MET establishments.

The purpose of this sub-chapter is to summarize some of the selected maritime education and training institutions around the world in terms of facilities, training methods and the various levels of training conducted.

3.4.1 Australian Maritime College:

The facilities at the Australian Maritime College (AMC) consist of a Norcontrol radar and navigation simulator and a Krupp Atlas shiphandling simulator. The shiphandling simulator is of the CGI type and is capable of producing a field of view of 200 degrees.

Some of the main features of the shiphandling simulator include the automatic transition from daylight to night, or vice versa, a capability of displaying up to 20 traffic ships, and a picture which can be switched to rear and side view as required. The Norcontrol radar and navigation simulator consists of 4 own ship cubicles, each equipped with radar, ARPA, controls and displays.

Recently AMC has developed a new situation monitoring system called SIMON and a debriefing facility which are interfaced to the simulator. As well, real GPS receivers are fitted into each own ship cubicle. The installing of the GPS receivers has led to the redesigning of the SIMON program so that each own ship positional data can be directed to the receivers.

The AMC facility has a fully equipped control room where simulation exercises are set up, controlled, monitored and recorded by the instructor.

The basic simulation training programs which are conducted at the AMC are:

(i)	Radar surveying	3 weeks
(ii)	Radar observer	3 weeks
(iii)	Radar simulator	5 days
(iv)	ARPA	3 days
(v)	Pilotage + radar	3 days

The introduction of the Krupp Atlas shiphandling simulator into the AMC simulation training program has led to the integration of radar, ARPA, electronic navigation aids, watchkeeping and shiphandling skills within the deck officer Diploma in Nautical Science scheme, instead of being offered in block short course form. This integration of simulation training system is also applied to the certificate of competency Diploma (Shipmaster) scheme.

The current simulation training courses conducted at the AMC other than by the integrated programs mentioned above are:

(a)	Pilot's Shiphandling course	5 days
(b)	Advanced Navigation and ARPA course	5 days
(c)	Advanced Navigation only	2 days
(d)	Ship Master's Shiphandling course	4 days

The pilot's shiphandling course is aimed at both experienced and inexperienced mariners. It provides a valuable first time experience for the latter and the opportunity to enhance and develop the skills of the former. The course is organized on a workshop basis which covers both lectures and practical training. A maximum number of five and a minimum of three students is anticipated for this course.

The advanced navigation and ARPA course is aimed at officers in charge of a navigational watch on ships fitted with automatic radar plotting aids (ARPA). The number of students for this course is limited to nine. The course is organized in three stages, namely - theory and demonstration, practical exercises and navigational procedures.

The objectives of the ship master's shiphandling course is to examine shiphandling theory and current practice and, to provide practical experience under simulation of the handling characteristics of various types of vessels. The prerequisite to this course is an AMC advanced navigation and ARPA course. The maximum viable number of students for this course is four.

3.4.2 Maritime Operations Centre - U.K.

The navigation and shiphandling simulation facilities at the maritime operations centre, Southampton Institute, Warsash Campus comprises:

(a) Manned Model Shiphandling
(b) Bridge Simulator
(c) Radar and VTS Simulator

(a) Manned Model Shiphandling: The manned model shiphandling facility is one of only three manned model shiphandling centres in the world. The idea of this system is that while simulators were excellent for the harbour approach phase in pilotage waters, considerable inadequacies still existed in the training of personnel in pure ship handling at the berth approach phase. The manned models consists of six ship types ranging from 40,000 DWT to 500,000 DWT tonnes which utilize a lake, the area of which is approximately 13 acres.

The current training program for this system consists of:

(i) Standard Manned Model Shiphandling course - 5 days.

(ii) Special Manned Model course - by special arrangement.

(iii) Basic Pilot Training course - 3 weeks.

(iv) Advanced Pilot Training course - 2 weeks.

The aims of the standard manned model shiphandling course is to enable officers to develop their existing skills and understanding of the concept involved in shiphandling, with special emphasis on slow speed ship control. The practical exercises undertaken are supplemented by discussions and films.

The special manned model course is aimed at specific training needs and can be conducted by special arrangement. The basic pilot training course is designed for new entrants to a pilotage service before their shipboard training with experienced pilots. The advanced pilot training course is designed for pilots nearing completion of a training program and also for serving pilots.

The manned model and shiphandling simulator course are integrated to both pilot streams. For the basic pilot course, one week is spent on the manned model and two weeks on the bridge simulator and, for the advanced pilot course, one week is spent on the manned model and one week on the bridge simulator.

(b) Bridge Simulator: The bridge simulator comprises a Norcontrol simulator and a Racal-Decca simulator. The Norcontrol simulator was commissioned in the summer of 1993. The Norcontrol simulator consists of the following facilities: telegraph, combinator/throttle, ARPA, twin VHF, internal telephone, doppler log, Radar, GPS, Decca Navigator, Loran C, DF and Echo Sounder, steering console and magnetic compass.

At the optical centre of the bridge is a pull down compass repeater with azimuth ring. An additional single channel visual system can scan through 360 degrees. It has a zoom-in binocular facility and can be used for taking bearings.

The simulator is of the CGI type and has a horizontal field of view of 210 degrees capable of holding up to 60 traffic ships of up to 38 different ship types. The transition from daylight to night, or vice versa, if required, occurs gradually in the real time of the exercise. Six tugs are incorporated for berthing and unberthing exercises.

The instructor's station consists of two control consoles together with seven colour monitors which show the same 210 degrees scene as that on the bridge. Each exercise is recorded and can then be played back (in fast time if necessary) on a console in the separate debrief station. The action and speech of those on the bridge are monitored on video. An XY plotter and matrix printer provide additional data for use when debriefing.

The Racal-Decca simulator is of the nocturnal type which has a fully equipped bridge including two radars and a Decca Navigator, with a field of view of 100 degrees.

The simulation training program comprises:

- (i) Bridge Team Management course - 5 days.
- (ii) Bridge Watchkeeping Preparatory course - 2 weeks.
- (iii) Emergency Procedure course - 3 days.
- (iv) Ship Simulator Operator's Training course - flexible.
- (v) Basic Pilot Training course - 3 weeks.
- (vi) Advanced Pilot Training course - 2 weeks.
- (vii) Special courses.

The bridge team management course is aimed at convincing officers that it is necessary to plan the vessel's passage from berth to berth and that the passage must be executed in such a manner as to make optimum use of resources of manpower and equipment.

The bridge watchkeeping preparatory course is designed for Deck Cadets in the closing stages of their training. The aim is to consolidate potential officers' previous training and prepare them for all aspects of a watchkeeping officer's duties. A remission of six weeks sea service is granted for cadets who satisfactorily complete the course.

The emergency procedure course is designed to provide the opportunity to experience and analyse various threatening scenarios and demonstrate procedures to assist in the safe conduct of the vessel.

The ship simulator operator's training course is flexible and designed to train the staff of establishments who are purchasing ship and radar simulators to be efficient operators. The basic and advanced pilot course which are integrated with the manned model course have been mentioned under the manned model title. Special simulation courses are frequently adapted or designed to meet the specific training objectives of the client organization.

(c) Radar and VTS simulators: The radar and vessel traffic services (VTS) simulator facilities have four own ships installed by Racal Simulation. In 1993 a new Norcontrol simulator (dedicated to VTS) was commissioned. The simulator equipment has a complete range of navigational aids interfaced to the simulator including Decca Navigator, Loran C, satellite Navigator, MF/DF, Echo Sounder, Fog Signals and Multi-Channel VHF. One own ship is additionally fitted with a Racal Raster "Brightrack" radar.

The current courses provided are:

(i) Navigation Control.
(ii) ARPA.
(iii) Radar/ARPA Updating for pilots.
(iv) Radar Surveyors.
(v) Updating plus VTS for pilots.
(vi) Radar Appreciation for Small Craft Personnel.
(vii) Radar/ARPA Appreciation for Electronic Maintenance Personnel.
(viii) Radar/ARPA Updating for Masters and Navigating Officers.
(ix) Radar/ARPA Training for High Speed Ferry Personnel.
(x) Radar Simulator Operator/Lecturer.

(xi) Radar/ARPA Appreciation for Legal Personnel.

(xii) Small Vessel Navigation and Radar Course for personnel who do not currently require statutory certification in the use of radar and navigation aids.

The introduction of VTS centres in many ports of the world is causing much greater involvement of shore based personnel in the movement of ships. To meet these new requirements, the following courses have been developed:

(i) VTS Management course.

(ii) VTS and Maritime Training course.

(iii) Special VTS Training courses to the particular requirements of individual Port Authorities.

3.4.3 Fachhochschule - Hamburg:

The facilities at the simulation centre in Hamburg Fachhochschule consist of a shiphandling simulator, a Krupp Atlas Electronic (KAE) radar simulator and, radar and navigation systems. The radar facility has three own ships holding forty targets, each equipped with a KAE ARPA 8500 and a KAE 6500 radar which can be linked with the shiphandling simulator at the Shipoperation and Simulation Facilities (SUSAN).

The shiphandling simulation courses conducted at SUSAN are designed to meet different target groups as follows:

<u>A1 Masters</u>: 3 day course in Container Vessels, or similar, and a 5 day course in Tankers (VLCC) or bulk carriers. The objective of this course is to familiarize

the master with all routine tasks as well as to develop a strategic plan to avoid errors, involve the officers in the decision making process and to cope with emergency situations which may arise within a risk management program.

A2 Chief Mates: 3 day course in Container Vessels or similar and, a 5 day course in Tankers (VLCC) or bulk carriers. At the end of the course participants should be able to handle all manoeuvring tasks normally carried out by the master, assist the master in difficult situations and be able to take over the master's position even with very short notice.

A3 Watch Officers: 5 day course. The objective of this course is to carry out all routine shiphandling tasks responsibly. Risky manoeuvring situations which can arise very quickly must be managed without assistance.

The overall objective of the above target groups is to be able to understand optimal ship operations following defined safety and economy requirements from confrontation with realistic situation and developments.

B1 Cadets with seagoing experience: 9 weeks course (3 hours per week). Participants must be able to stand a bridge watch under normal conditions. These conditions also include systems failures. Student should be able to define situations and developments when competent assistance is needed and establish this assistance by early and proper information.

B2 Cadets without seagoing experience: Same as B1 following a two weeks seminar (8 hours per day). The acquired knowledge gain from the previous theoretical subjects taught, will be put together to form a complex shiphandling situation which the student has to understand and, be able to evaluate in order to define proper actions. Student must know the governing parameters influencing the man-ship-environment system.

The overall objectives for the cadet system B1 and B2 are to know information which is needed for the decision making process, to be able to select and evaluate relevant information and, to decide and communicate within the man-ship-environment system. All watch officer's routine tasks must be carried out responsibly.

C1 Pilot-apprentices: 5 day course (8 hours per day). Pilot apprentices are trained to become familiar in their future area of service. They must be able to perform all routine manoeuvres with the whole variety of vessels calling at their area of service. The master-pilot relationship must be established regarding legal and local peculiarities. All necessary internal and external communication has to be performed in a safe and effective manner.

C2 Pilot, experienced: Normally a 5 day course (8 hours per day) or according to clients requirements. The objectives are to reproduce situations and conditions which led to casualties, and to investigate and evaluate them in order to derive strategies to avoid future accidents. The pilot should be able to cope with emergency situations within the risk management program. He needs to be familiar with all actions to be taken after an accident to minimize damage.

D1 VTS-operator-apprentices with seagoing experience: The duration and content for all VTS courses depends upon entrance qualification and local needs. The participants must understand the role of a single vessel as influencing parameter of the man-traffic-environment system and the interaction of all participants of the complex traffic system. They need to learn to control safety and efficiency by communication. They need to become familiar with all actions to be taken after an accident to minimize damage.

D2 VTS-operator-apprentices without seagoing experience: The participants need to become familiar with shiphandling of the types of vessels serving the area under various conditions, in addition to the objectives for D1 operators.

D3 VTS-operators, experienced: The situations and conditions which led to casualties shall be reproduced, investigated and evaluated in order to derive strategies to avoid future accidents. They should develop a sixth sense for dangerous traffic configurations in an early stage. They need to know, understand and to apply VTS-strategies.

To meet the overall objectives - traffic service operators need a thorough knowledge of the area of service under various weather and traffic conditions. They need to develop a comprehensive understanding of the real traffic performance as a reliable basis of their traffic information and organization work. They need to know, understand and to apply the influencing parameters of the man-traffic-environment system. All necessary communication has to be performed in a safe and effective manner.

E1 Shiphandling simulator instructors with simulator experience: 1 or 2 day course (8 hours per day). The participants are trained to understand the significance of briefing, simulation run and de-briefing contents for training, predict the probable results, assess the results and score it. They should be familiar with a great variety of exercises and strategies to meet exactly the trainee's needs. They should be able to develop enhancing programs to upgrade a simulator hardware and software regarding the cost-benefit-ratio.

E2 Shiphandling simulator instructors without simulator experience: 1 or 2 day course (8 hours per day). The instructors must learn how defined training objectives can be obtained by effectively applying already prepared exercises and simulation modules. They need to know, understand and to apply defined methods and strategies to create new exercises and to perform simulation. They should be familiar with the most important technical details of the simulator.

The overall objectives of the shiphandling instructors are to be familiar with simulator didactics to make optimum use of a simulator. They must know how to influence the trainee's psychomotor, affective and cognitive domain by the teaching tool (simulator), by content and performance of the exercise and by actions and behaviour of the instructor himself to obtain a maximum transfer of skills, attitudes, knowledge and experience into reality.

3.5 Simulation as an assessment tool.

Comparisons of traditional and simulation training methods have been discussed in sub-chapter 3.2 and, the ways and means in which the traditional methods are being assessed in terms of shiphandling operations. The traditional training methodology has come a very long way and has been used quite successfully in its application of the upbringing of seafarers.

It can be said that the existing assessment method of measuring performance is partially redundant due to the rapid advance in technology, that is partially redundant in the sense of its inability to test the various practical skills in a physical or hands-on experience or exercise.

To overcome this partial redundancy and, therefore to meet the existing technological situation, simulation can be used as an assessment tool for this purpose. However, it must be noted that simulation cannot totally replace traditional assessment methods.

Research has shown that simulation can be effectively utilized as an assessment tool if the training program is carefully structured, monitored and controlled. However it is being argued and claimed that simulation is not a proper tool for assessment purpose. Some of the claims being put forward are:

(a) The precise characteristics of good shiphandling were difficult to define or reach agreement upon.

(b) Testing of practical skills of a seafarer cannot be scored with confidence.

(c) The monitoring problems that arise in trying to measure performance by score.

(d) The difficulty in quantifying achievement levels in some of the components of any scoring scheme.

(e) Experience dictates that practical shiphandling skills cannot be measured in this way.

A research assessment study conducted by Muirhead (1987, 56-61) in Hamburg, Cardiff and AMC simulation facilities gave remarkable results. In the research assessment process, exercises covered the following basic skills:

(a) The handling, stopping and turning of a vessel.
(b) Helm orders and conning the ship in enclosed waters.
(c) Effects of propellers upon ship behaviour.
(d) Turning a vessel short-round: Single or twin screw.
(e) Bringing a ship to a single anchor.
(f) General principles in handling the vessel during berthing and unberthing operations.
(g) Communications: ship-shore; ship-ship; internal.

The research showed that prior to the simulation assessment exercise process, students were subjected to an oral examination. A total of 41 students were being assessed which included 38 students preparing for a first watchkeeping certificate. None of the subjects assessed had any previous shiphandling experience. X-Y plotter, data print-out, tape and visual observation were used to give a clear picture against which the level of skill could be evaluated.

The resulting outcome from one of the assessment tests showed that in the oral assessment, 29 students were tested, 22 passed and 7 failed. In the simulation assessment, 15 passed and 14 failed. A result of (76%) and (52%) respectively. The difference in the above results may lead to some limiting factors such as:

(a) Lack of appreciation of a vessel's handling characteristics at slow speed.
(b) The inability to judge speed of approach.
(c) Lack of field of view.

(d) A number of simulator failures could be attributed to a failure to follow recognized patterns or standards of manoeuvring behaviour.

(e) Difficulty of distance perception, particularly of nearby objects was a common problem.

However prior to the assessment test the majority of students had acquired a considerable number of hours in the own ship models. Students were also briefed to make use of the officer forward and aft to obtain distances off navigation marks and jetties. The studies showed that those students who followed the briefing process handled the ship in a much more confident and successful manner than those who ignored it. Students also claimed that their poor performance was affected by the presence of the assessor. However this makes little difference to the result.

The general consensus of the resulting outcome shows that (95%) of the students being tested indicated that each task was considered to be realistic and set at an appropriate skill level. Evidence illustrates that the simulator trained student is more likely to carry out a seamanlike and effective performance than those non-simulator trained students, where ship-handling experience levels are low or non-existent.

The research has concluded that simulation is indeed a valuable tool for assessment purposes provided that it is conducted in a systematic and carefully structured, monitored and controlled manner.

As recently as 1993, the AMC had introduced a new approach to a continuous assessment program in simulation training. The aim of this new approach was to develop and design a student activated self assessment and instructor free program, which is intended to increase the availability of the simulator for student use. The program exercises are designed to meet particular objectives. For example: Manoeuvre - turn a ship short-round in a navigational channel with no wind or tide.

The duration of the training exercise for this new program is forty-five minutes during which the students have complete control, from starting to the completion of the exercise utilizing a specially programmed computer. Ten minutes are given for preparation in which time the student is given a folder containing the following:

(a) exercise information.
(b) objectives of the exercise.
(c) relevant publication required.
(d) exercise questionnaire.
(e) computer operating instruction.

On completion of the exercise the student activates the computer for a printout of plot recordings, answers the questionnaire provided and completes all movements in the simulation logbook. The instructor has in his possession copies of all exercises conducted for monitoring purposes.

3.6 Conclusions.

Although various quarters have identified and are convinced as to the effectiveness of simulator training and these are well documented, there still exists conflicts of opinion and beliefs on this issue. Also questions are raised as to whether it is proper to train students under simulated conditions.

In light of the foregoing together with the age and time we are living in, students cannot be denied the opportunity to be trained in what technology has to offer. Without doing this means degrading the training standards and above all will be extremely dangerous to the industry.

Efforts have been made to standardize the level of training globally by way of Conventions. The International Conference that adopted the STCW/78 convention under its Resolution 18 recommends radar simulation training only for masters and deck officers.

Additional training under Resolution 17 for masters and chief mates of large ships and ships with unusual manoeuvring characteristics is also recommended. Before assuming command of a ship, the master should have attended an approved shiphandling simulator course or an installation capable of simulating the manoeuvring characteristics of such ship.

With the above in mind and looking at some of the selected institutions around the world, a totally different picture emerges. The lesson which can be learned is that simulators are used for training not only for masters and mates level but, are extensively being used in all levels of training in the MET system.

The trend towards technological training signifies the inadequacy of the traditional training method alone in the ever increasing technology in the maritime industry. However the combination of the two methods of training is essential in the enhancement of the seafarers knowledge and skills.

CHAPTER 4

IDENTIFICATION OF NEEDS

4.1 The concern of IMO.

There have been numerous marine disasters resulting in the pollution of the marine environment and lost of human lives. Due to these marine accidents extreme pressure has been put on the shoulders of national and international regulators which has focussed their attention on the need to achieve higher standards of competency for mariners.

The International Convention on Standards of Training, Certification and Watchkeeping (STCW/78) laid down minimum standard requirements for the training of ships' personnel. The provisions contained in the convention are based on International agreed minimum requirements for on-the-job experience, which may or may not include training and, examination of an applicant's knowledge of matters contained in a prescribed syllabus. However, there is no requirement for assessing an applicant's ability to perform the function of the position for which a candidate seeks to be certificated.

The STCW/78 convention entered into force in 1984. Since then, technology has gradually evolved and to date has reached a very high standard. The advance in technology and design of equipment makes it necessary to have active mariners become acquainted with these changes. This calls for a greater need for adjustment in the training methodology to reflect the change in technology. The maritime community and in particular the International Maritime Organization (IMO) have great concern resulting from such changes.

The Sub-Committee on Standards of Training and Watchkeeping (STW), in their 22nd session meeting in January 1991, discussed the adequacy of IMO instruments in preventing and mitigating marine pollution incidents. In the process of this meeting, consideration was made to amend the 1978 STCW convention to include training in engine control and cargo handling simulators.

The outcome of this meeting led IMO's Maritime Safety Committee (MSC) to invite member governments to provide information about simulators in their countries, in order to consider simulator training in general and, whether to prepare recommendations on such training. In the invitation no mention was made of ship's bridge simulators. The result of the invitation was disappointing due to the low response. In 1992, MSC circulated a second questionnaire requesting information, this time including ship's bridge simulators.

In March 1993, IMO's STW Sub-Committee convened a meeting and drew up a plan for a thorough revision of the convention which would culminate in an international conference in 1995. The draft report of the Working Group on amendments to the STCW convention (STW/WP8) in considering `The Principles Underlying the Revised Convention' made the following observations:

> The group noted the view of MSC.61 (a Maritime

Safety Committee paper) on the value of simulator training and recommended administrations to encourage all types of simulator training for seafarers and, taking into account the additional benefits to and expertise provided by such special training to those who attend approved courses involving the use of simulators, where appropriate, to favourably consider such training when assessing sea time requirements.

The revised Convention should, in addition to addressing the acquisition of knowledge, also emphasize the acquisition and assessment of skills and should provide for a functional approach to training.

The observations made by the Working Group has indicated a major change in the IMO approach to the training, examination and certificating of ship's personnel. The approach is now directed towards skills-based training rather than knowledge-based training. In other words, candidates will be assessed on abilities and not simply on knowledge of how to perform tasks.

It is obvious that there is a need to increase the role of simulators not only for ship manoeuvring and watchkeeping training but also for bridge team management training. The recent disaster of the British ship Herald of Free Enterprise, with a loss of 193 lives, caused IMO to take the following step in October 1989 by adopting resolution A.647(16) which bears the title: `IMO Guidelines on Management for the Safe Operation of Ships and for the Pollution Prevention.'

The necessity for good management on board is more and more recognized by not only guaranteeing a high level of know-how of those involved, but also by making use of this know-how by those involved.

In his key note address at the International Summit on Safety at Sea held in Oslo, in April, 1991, in its theme, `Safety and new challenges in the years to come' the Secretary-General of IMO stated:

> Thirteen years have now passed and it is recognized that the time has come for changes. In particular, there is a growing need for greater specialization in training. The use of simulators was deliberately excluded from the 1978 convention but the greater sophistication of ships and the need for greater maritime and environmental safety calls for greater use of this equipment.

The advent of the IMO ship manoeuvring requirements and the legislators' awareness that there is a need to improve the manoeuvring characteristics of some vessels, should inevitably, lead to improved marine training in terms of stipulating the use of computer based ship manoeuvring simulators to impart ship control knowledge.

4.2 IMO - STCW simulator standards.

At the present time there are no IMO-STCW simulator standards in place. IMO processes are currently revising the existing STCW/78 convention to find solutions in order to develop standards or guidelines to promote the effective use of simulators. The areas which were considered by the Intersessional Working Group (ISWG) as being suitable for development as guidelines are as follows:

(i) the qualification and certification of simulator instructors;

(ii) support facilities for effective briefing, monitoring, debriefing and skill assessment;

(iii) skills assessment - identification of tasks and skills to be assessed.

As the process of revision of the convention is in the early stage, further consultancy work to specify specific simulator matters would be premature until the standards and levels of competence in the functional approach have been developed by IMO instruments.

The ISWG identified a number of areas suitable for inclusion within the revised convention and associated resolutions. The following identified areas are abstracted from the ISWG paper.

The potential uses of simulators for skill enhancement and assessment are listed as follows:

Ship operations:

(i) radar and collision avoidance systems;

(ii) navigation control;

(iii) watchkeeping skills;

(iv) shiphandling (primary level);

(v) shiphandling (advanced level);

(vi) bridge team management (including internal communication);

(vii) electronic navigation equipment;

(ix) emergency response training (SAR, MOB, Steering gear etc.);

Cargo operations:

(i) ballast control;

(ii) cargo operations (including stability, stress and damage control);

Communications:

(i) GMDSS operator certificate training;

Machinery space operations:

(i) marine diesel, steam and gas turbine propulsion plant;

(ii) auxiliary machinery systems;

(iii) electrical machinery systems;

(iv) cargo handling and deck machinery;

(v) detection of machinery malfunction, fault location and rectification;

(vi) emergency response training (fire, pollution, power failure);

(vii) engine performance monitoring and evaluation;

(viii) perpetuation of equipment life;

(ix) equipment breakdowns and impact on the operating system;

(x) steering gear operations;

(xi) watchkeeping skills;

Revalidation:

(i) refresher and/or upgrading training.

Assessment:

The use of simulators as an assessment tool was fully supported by the ISWG working group and it agreed that simulators could be used effectively to assess the levels of skills and thus provide a measure of competence to perform tasks against defined standards subject to the following criteria:

(i) clear training objectives are established;

(ii) exercise tasks clearly relate to training objectives;

(iii) effective pre-briefing, exercise monitoring and de-briefing facilities and techniques are utilized;

(iv) assessors are adequately trained for the role;

(v) the simulator has the capability of providing a suitable operating environment for the chosen objectives and skills to be assessed.

The remission of qualifying sea service for approved simulator training is granted by a number of countries. Since this is a matter of sufficient importance, the ISWG working group felt that it is necessary to warrant further consideration by the STW Sub-Committee when the revised convention and associated resolutions are sufficiently developed. Technical specifications with the range of simulators available today is too complex to expect IMO to produce a specification acceptable to all concerned.

National administrations are encouraged to recognize the value of simulator training for watchkeepers and senior officers and to put into place the necessary procedures to enhance their use. It was decided that simulator training should not be made mandatory at this early stage.

There has been a rapid growth in the range of computer software programs suitable for use as teaching and training tools for seafarers. It has to be noted that not all software may be suitable for maritime training purposes and, they should be selected only after careful investigation and evaluation as to the software program's suitability and effectiveness as a learning tool. The key to the selection of programs is a follows:

(i) what are the teaching and training objectives?

(ii) in what way can the software enhance the learning process?

(iii) what type of programmed learning is it?

(iv) does the program relate to workplace practice?

(v) can it be used to measure levels of knowledge and/or the acquisition of skills?

The recognition or approval of maritime computer software should be based on software which is directly related to the particular knowledge or skill requirement referred to in any IMO guidelines which may be developed for the training and skill assessment of seafarers.

4.3 IMSF simulation classification

The need for a simulation classification system has been described in sub-chapter 2.2 under the heading - "Definition and Categorization of Simulators." However, the International Marine Simulator Forum (IMSF) has prepared a proposed draft classification system (APPENDIX-B) for recommendation to IMO for consideration in the preparation for the revision to the 1978 Convention on Standards of Training, Certification and Watchkeeping (STCW) in their theme, `Towards Development of an International Standard for Ship Operation Training Simulators.'

The goal of the IMSF is to prepare a document classifying and describing ship operation training simulators to assist the International Maritime Organization and Maritime Administrations in their consideration of the use of simulators for training and licensing of seafarers.

The present situation in technology has seen a different variety of products, not always to a common standard. This leads to confusion and misunderstanding among the users of simulation. This calls for the need for a recognized simulation standard. The work of the IMSF is to endeavour to formulate a standard which would be internationally recognized. IMSF anticipates that by late 1996, a complete document will be handed to IMO for adoption as an international standard being the views of those associated with marine simulation.

4.4 The simulator as a standard training tool.

The trend in the modern maritime world is that the number of ship's personnel is becoming drastically reduced, not only because of the changing technology, but also due to the fact that ship owners are attempting to cut costs. As a consequence of this trend, student officers will suffer in the lack of preparation in their sea-phase training.

The recent changing pattern in the maritime training system, where students are directly recruited into maritime institutions soon after leaving high school, has further increased the gap between training and the workplace. Therefore, the training for shipboard competence rests today more than ever with maritime institutions.

Muirhead (1994, 4).

To reduce the gap between training and the workplace, maritime training can however be brought closer to shipboard practice by the use of simulators. As has previously been mentioned, simulation training is the only method which can meet the present training needs and transfer of skill to the real world. Simulators will for two reasons become one of the main tools for training seafarers:

(i) they can replace todays incidental gaining of experience;

(ii) they are the most natural tool for training seafarers on a complex system.

Navigation, collision regulations, shiphandling and watchkeeping training can be provided in a simulator in one sequence with an increasing amount of stress laid on the operator-trainee achievement which can never be reached in classroom instructions with textbooks and wooden models. Simulators have become a main tool for training and education must be directed towards the training needs.

Most maritime training institutions around the world, particularly the developed countries, are equipped with simulators that range from the simple to the more sophisticated. However, over the past few years the delivery of simulators to developing countries has increased in pace.

Recent developments of simulators means they are becoming more accessible and affordable to many institutions in terms of navigation, blind radar and engine control simulators. The introduction of other simulators such as GMDSS, handling of hazardous liquid, bulk and container cargoes with PC based systems is rapidly gaining acceptance.

Muirhead (1994, 6.).

4.5 The shipping technology.

The technological changes in ships have been radical and rapid. In many cases they have had a marked effect on the performance of seafarers. The size, speed, specialization and other technological aspects of ships have changed beyond all recognition compared to the ships which we have been accustomed to in recent decades.

The automation of the propulsion installations, the introduction of new cargo accommodation and handling facilities, new navigation equipment which have resulted in a new definitions of the tasks of the seafarers and the introduction of new shipboard management systems are believed to have had a considerably profound effect upon the professional life of mariners.

New technologies have developed very quickly and at the same time the shipbuilding quality has improved. Due to these major changes that have occurred in recent years in ship technology and, regardless of the size and speed of the vessels but as a direct consequences of the introduction of automation and other sophisticated equipment, there are two major changes that have occurred in recent years as have previously been mentioned:

(i) the size of the crew has been reduced substantially;

(ii) the complexity and sophistication of equipment has increased rapidly.

With the adoption of unmanned engine rooms and bridge control of the main engine, the bridge now contains, in addition to its traditional navigation equipment, many alarms and control functions related to the engineering plant and, more and more frequently related to the cargo installation and various safety installations and equipment. The navigation gear itself is all the more numerous and more sophisticated.

All these changes emphasize the need in modern ships for all senior officers and watchkeepers to be thoroughly familiar with the specific equipment in a ship before assuming any responsibility. There is no doubt that well maintained modern bridge equipment allows competent officers to handle a multiplicity of tasks with very small watches but, it is also true that there is a great deal more for any officer to learn about modern ships before he is ready to take over.

4.6 Is simulation the answer ?

In our modern shipping world, it is generally expected that newly graduated officers can be immediately assigned to all kinds of watchkeeping functions, while only a very short initiation period can be allowed for. Due to the smaller groups of officers on board, on-the-job training of junior officers by senior officers (whether it be in the engine room or in the deck department) has become more difficult than in earlier days. Often this is not possible at all.

Faced with the unfortunate situation regarding on-the-job training for student officers, a training system has to be established in order to compensate for this dilemma. Therefore, the answer to the question raised in the title of this sub-chapter has to be `yes', simulation is the answer to training student officers in the existing situations.

It is true that the use of simulators cannot totally replace the real hands on experience on board ships, which is the first and foremost choice if it is possible. However, simulation training will enable student officers to perceive the real world condition as closely as possible.

In defining the training needs, the student's knowledge has to be determined and based on this knowledge, training objectives can then be considered. Legal requirements, experts (professionals), expert bodies (e.g. IMO), instructors, students and casualties are the basic sources which are normally consulted to specify training. Experience has proved simulators to be the tool to provide a quick feedback and meet the objectives of training.

Froese (1988, 4).

Acquiring a training ship is far too expensive for a training institution to run and maintain. In this regard by identifying the needs to meet respective objectives, the more developed countries and few of the developing nations have resorted to simulators for training. It will be the simulator facilities which will be indispensable in achieving these ends, being well suited to meet the needs of training seafarers in the maritime education and training system in Fiji.

4.7 Conclusions

The existing Standards of Training, Certification and

Watchkeeping for seafarers (STCW/78) Convention is currently under review. It will be very interesting to see what will be the final outcome of this revision and the impact it will have on the training of seafarers particularly in terms of marine simulators.

The decision by the Intersessional Working Group (ISWG) not to make simulation training mandatory at this early stage is a wise move. This is because most training institutions around the world still do not possess such equipment, particularly in the developing nations. However this decision still has to be finalized by IMO's STW Sub-Committee for adoption.

Would making this equipment mandatory be justifiable in the eyes of the regulators ? The majority (75%) of the member states to the STCW Convention are from developing countries and to make simulation training compulsory at this early stage would be unrealistic.

The author feels that the regulating bodies i.e. national and international regulators should ensure that all training institutions around the world be provided with this equipment before considering making it mandatory

Despite the decision that shiphandling simulation training is not to be made mandatory at this early stage and, regardless of the criticism of the system that it is no substitution for the real hands on experience on board ship, simulation technology is not stagnant but is moving ahead, and in the author's view marine simulators will become a main tool in the training of seafarers in decades to come.

CHAPTER 5

DEVELOPMENT OF MARINE SIMULATION TRAINING IN THE FIJI MET SYSTEM

5.1 The impact of development

The Fiji school of maritime studies (SMS) of the Fiji Institute of Technology (FIT) has been designated by the South Pacific Forum Shipping Council to be the Principal Training Centre for seafarers in the South Pacific Region. The decision was incorporated with the South Pacific Bureau for Economic Co-operation (SPEC) now known as the Forum Secretariat (which constitutes fifteen member countries including Australia and New Zealand) in which Fiji is a member.

The result of this appointment has given the SMS the responsibility to formulate its long term planning as regards to training facilities, training equipment and manpower development in order for the school to fulfill its role, and to align the standards of training in accordance with national and international training requirements. Unfortunately the SMS is slow to meet some areas in its planned development due to financial and other obvious constraints.

In considering the rapid change of shipping technology in the modern maritime world, the development of a marine simulation training scheme in the Fiji maritime education and training (MET) system will have a significant impact on the whole training infrastructure in Fiji. This means that both the SMS and the maritime safety administration i.e., Fiji Marine Board (FMB) will be greatly effected by this change.

The impact which this change will bring to the school is that, potential simulation instructors (both deck and engineering department) will have to be identified and the SMS has to ensure that they are properly trained and qualified. Preference should be given for those with class 1 master and class 1 engineer (Foreign Going) certificates of competency respectively, with vast sea-going experience.

The SMS has to identify and to ensure the acquisition of the appropriate simulation equipment to meet the necessary training needs and to provide facilities to house these training tools. The major element of this project is the financing of facilities and equipment; the school has to make every endeavour to approach various donor countries such as Australia and Japan for this very important issue, and to acquire the full support from the Fiji Government - Ministry of Education, Science and Technology, and the Ministry of Foreign Affairs.

The impact to the maritime safety administration i.e., Fiji Marine Board is that, it has to ensure that the examiner for master and mates and, equally so, the examiner for engineers, be familiar with the simulation system for examination and assessment purposes.

The proposed future introduction of marine simulation training in the MET system in Fiji means that the existing Fiji Marine Act has to be reviewed and updated to include various simulation training. In the present Act, only the radar simulation training has been covered. Therefore it is the responsibility of the administration to ensure that the training segment of the Act is reviewed, processed and passed by legislation. It is emphasized and encouraged that both the SMS and the administration work hand-in-hand in order to achieve this end.

5.2 The proposed development approach

The process of the acquisition of the appropriate simulation equipment for training seafarers is crucial as far as the MET in Fiji is concerned. As has previously been mentioned the advance in simulation technology in the modern maritime world has reached an extent of very high standard, in that one can hardly distinguish the real from the realistic in such equipment. These equipment are available in the market ranging from a simple desk-top simulator to the very sophisticated full bridge simulator.

Regarding the degree of availability of the simulation system, the SMS has to closely and carefully analyse the type of training tool required before any commitment to equipment is made. In so far as the SMS is concerned, the best way to pursue the acquisition of simulation equipment, is by the school initially identifying the training objectives and, based on these objectives (this will depend upon the type of specialized course proposed to be conducted) the equipment design specification can then be drawn to meet the school's training requirements.

Two factors must be borne in mind when considering the design specifications of this equipment and these are:

`flexibility of use' and `capability of development'. Having specified the user requirements, an `invitation' to tender has to be prepared and communicated to various simulator producers around the world for procurement purposes with the full support from the Government.

It is emphasized that the school act immediately to expedite development. On site installation may be greatly expedited if documentation is made available well in advance. In fact, with a long lead time in the project, attempts should be initially made with the manufacturers of simulators for an agreement to be reached to involve SMS staff early in the project both in software and hardware configuration so that installation is only a milestone in the project and not a traumatic point for transferral of responsibility.

5.2.1 Types of equipment required

The immediate requirements in so far as the SMS is concerned is the radar simulator since this is required by legislation. Therefore the school has to take immediate steps to acquire this training equipment. In the consideration of acquiring a radar simulator trainer however, it is proposed that a ship bridge simulator be acquired simultaneously in order to save time. Perhaps it would be economical to acquire both equipment in one package.

With a wide range of simulation system technology accessible today, the Fiji school of maritime studies has the advantage of choosing from the many varieties of simulation training equipment. In comparing a PC based-trainer as against a hybrid or a full mission simulator, this equipment is more or less capable of achieving the same training requirements. The disadvantage of a PC based-trainer however, in the author's view, is that, although it is cheap and economical, it does not give the students the right `feel' of the ship's environment.

What has to be borne in mind is that training of seafarers and in particular the cadet officers has to be in a ship-like environment so that they can perceive the real world condition as closely as possible. Based on this philosophy, it is proposed that the SMS acquire a radar navigation blind pilotage simulator with at least three own ship cubicles, and a low cost ship bridge navigation simulator capable of producing at least 240 degrees horizontal field of view, and 35 degrees vertical field of view.

Due consideration should also be given to other simulation training equipment and in particular the communication simulator equipment. The radio communication system can be integrated into the ship bridge simulator or it can be a stand-alone. The system is available using PC's in full configuration which would fulfill the Global Maritime Safety System (GMDSS) training requirements.

The above mentioned simulation element is a particularly important piece of the training tool and has to be acquired together with the previously mentioned equipment, if possible. It is proposed that four work stations be acquired for this system.

Other simulation training equipment considered secondary to the school's training requirements for future development are: liquid cargo handling simulator, propulsion plant simulator, fisheries simulator, ballast control simulator, steam generation plant simulator, electrical power plant simulator, refrigeration plant simulator, oil-spill management trainer and vessel traffic management trainer.

5.2.2 Cost

The cost considerations for the SMS consist of three factors:

Initial Capital Cost: A decade ago, three to five million dollars was too high, five hundred thousand to two million dollars is an acceptable range today. The school has good potential to generate the initial capital outlay in this lower range.

Operational Cost: These recurring costs will be difficult for the SMS to handle. The normal staff augmentation required in the last decade (e.g. one to five additional staff for training and maintenance) is unacceptable. Therefore design and application alternatives are required to substantially lower this cost.

Space: The space available in the existing navigation bridge of the school may have difficulty in handling all needs and also may have major campus implications. The space requirement, therefore, must be reduced.

The approach to achieving an acceptable simulator cost must be based on the above factors, and a flexible simulator design architecture. For example, many training institutions around the world operate radar simulators. Experience has shown that substantial cost savings have been achieved when a ship bridge simulator is integrated with the radar installation - initial cost reduction, sharing of personnel and sharing of space. Pursuing the above example would adequately meet the SMS requirement.

5.3 Watchkeeper simulation training program

A three year deck apprentice course program is conducted at SMS on a term basis. However SMS has changed from term to semester basis to keep in line with the new direction taken by FIT which took effect in the beginning of the 1994 academic year. This means that the course schedule will take a few weeks longer (from 13/14 weeks per term to 20 weeks per semester). This changeover will best fit the simulation training program for deck apprentices to be integrated into the current curriculum.

The three year course program guides the apprentice to his or her first watchkeeper certificate of competency (Grade 3 Mate) after completing the final stage i.e. deck apprentice stage 5. It is assumed that the new look deck apprentice structure will take the following form:

Deck Apprentice Stage 1 (DA1) - first semester in school
Deck Apprentice Stage 2 (DA2) - at sea phase
Deck Apprentice Stage 3 (DA3) - second semester in school
Deck Apprentice Stage 4 (DA4) - at sea phase
Deck Apprentice Stage 5 (DA5) - third/fourth semester in school

Integration of the radar and ship bridge simulator into the cadet officer's curriculum will be progressive. A proposed simulation training program for deck apprentices is provided in APPENDIX C.

5.3.1 Training objectives

The training objectives for the deck apprentices' simulation training course will vary according to the individual course stage. In order to fully utilize the simulation facilities, a comprehensive list of deck apprentice training objectives for stage one, three and five is provided in APPENDIX D.

5.3.2. Training methodology

The deck apprentice stage one (DA1) includes the basic watchkeeping simulation training course in the first semester. The basic watchkeeping course will cover the following principal topics:

(i) Bridge Equipment Functions and Operations;
(ii) Lookout Duties and Responsibilities;
(iii) Helmsman Duties and Responsibilities;
(iv) Shipboard Terminology.

Each of the above topics will be for a 3-hour period (a total of 12 hours), in which time the intended training objectives should have been properly covered for the stage one apprentice. The topics will first be covered in normal classroom sessions before the actual simulation hands-on training. The simulator may be used initially for overview demonstrations to give the cadets a general feel for the bridge, wheelhouse operations and vessel interactions.

The deck apprentice stage three (DA3) in the second semester covers Coastal Navigation in the simulator. The principal topics are:

(i) Selected Piloting Technique;
(ii) Dead Reckoning;
(iii) Visual Position Fixing;
(iv) Vessel Characteristics;
(v) Safe Vessel Speed;
(vi) Watchkeeping Procedures.

Each of the above topics will be for a 3-hour period (a total of 18 hours), in which time the training objectives for the stage three apprentice should be adequately covered. Each topic will be covered in normal classroom sessions before the simulator exercise is conducted.

The deck apprentice stage five (DA5) covers two semesters i.e., semester three and four in the final apprenticeship stage. In semester three cadets will be trained in Collision Avoidance in the simulator. The topics will cover the following:

(i) Relative Motion;
(ii) Radar Plotting;
(iii) Application of Rules of the Road;
(iv) Vessel-to-Vessel Communications;
(v) Shiphandling/Emergency Shiphandling;
(vi) Watchkeeping Procedures.

The above topics will be divided into eight 3-hour periods (a total of 24 hours), in which time the intended (DA5) training objectives should be adequately covered. Simulator exercises will be conducted after the topics are covered in normal classroom sessions and completed as a "radar observer course".

In the fourth and final semester DA5 cadets will undertake the "Advanced Wacthkeeping" course in the simulator. This final session of the simulation training will be divided into four 3-hour periods (a total of 12 hours). The syllabus for this module will include all previous topics taken by stages one and three (DA1 & DA3).

All previous training objectives are assumed to have been achieved as a pre-requisite to this module. The principal training objective of this module is the integration of the requisite skills and knowledge to achieve consistent and coordinated shiphandling. Simulator review problems representatively spanning the breadth of training objectives will be conducted prior to graduation.

5.4 Senior officers simulation training program

The simulation training program for senior officers will be integrated into the current curriculum. The training programs will vary according to individual grades of a certificate of competency. A proposed simulation training program for officers in charge of the navigational watch is provided in APPENDIX E.

5.4.1 Training objectives and methodology

The simulation training objectives for senior officers will cover all navigational aspects which a student officer will be likely to encounter in real world conditions. These will include an understanding of the handling characteristics of various sizes of ships, and how to control the ship when environmental forces are present. The training objectives and the methods of training are contained in APPENDIX F.

5.5 Master simulation training program

The training program for ship masters will be integrated into the current curriculum which is anticipated to cover every aspect of shiphandling. The proposed ship simulator training program for ship masters is contained in APPENDIX G.

5.5.1 Training objectives and methodology

The simulation training objectives for ship masters will cover all aspects of responsibility expected of a master in commanding the navigation of the ship. The training objectives and methods of training are provided in (APPENDIX H.)

5.6 Short courses training program

Since the school of maritime studies is still in its developing stage in terms of the acquisition of simulation equipment, senior experienced sea-going officers and deck apprentices who are already qualified and graduated still need to undergo simulation training in order to be recognized in the shipping industry. Therefore a short course for simulation training will have to be devised and prepared for this purpose.

The frequency of these courses will depend upon the normal courses timetable program conducted at the school, and the time frame the simulator is available. A proposed short course program for simulation training is as follows:

(i)	Radar simulator	5 days
(ii)	Advanced Navigation and ARPA	5 days
(iii)	Advanced Navigation only	2 days
(iv)	Ship Masters' Shiphandling	4 days

The radar simulator course will be aimed at all levels of grades since this is a requirement under Fiji's legislation, and this will also be a pre-requisite to the advanced navigation and automatic radar plotting aids (ARPA) course. It is anticipated that a minimum number of 12 students take part in this course.

The advanced navigation and automatic radar plotting aids (ARPA) course will be aimed at officers in charge of a navigational watch on ships fitted with ARPA. A minimum of 12 students is anticipated for this course. The course will be organized to cover:

(i) Theory and Demonstration;
(ii) Practical Exercises;
(iii) Navigational Procedures.

The objectives for the ship masters' shiphandling course would be the same as those contained in APPENDIX H. This includes the examining of the shiphandling theory and current practice, and the provision of practical experience under simulation of the handling characteristics of various types of vessels. A minimum of 4 students is anticipated for this course and the entry requirement is an advanced navigation and ARPA certificate.

5.7 Simulator characteristics

The purpose of this sub-section is to describe the intended characteristics for both the radar simulator and the ship bridge simulator envisioned to meet the purpose of training cadets and experienced sea-going officers in the MET system in Fiji, with a view to future further expansion.

5.7.1 Radar simulator

It is considered that three own ship cubicles be provided. Each cubicle should be designed and constructed so that it can replicate a real ship's bridge as closely as possible. Suitable hardware and software configurations should be provided with a view to development capability as earlier indicated.

The design space should be capable of accommodating a minimum number of 9 and a maximum number of 12 students i.e. 3 or 4 students in each cubicle in any one course respectively. At least an automated radar plotting aids (ARPA) should be installed in one of the own ship cubicles and linked into the radar simulator system. Installation of ARPA in each cubicle would be an advantage, but this will depend on cost.

Basic equipment required in each own ship cubicle should include the following: steering system, radar and ARPA display (standard), Loran C, Decca navigator, MF direction finder, global positioning system (GPS), echo sounder, VHF system, intercom system and chart table.

5.7.2 Ship bridge simulator

The SMS should take advantage of the potential technology on small bridge designs that have shown effective use in certain training and research contexts. It is considered that the bridge simulator is to be designed in order to meet all training objectives for cadets, senior officers and masters as previously specified.

Economics of initial cost, operation and space can be achieved by careful tailoring of the bridge simulator to fit the school's existing facilities. The ship bridge simulator in mind is more compact than the typical bridge simulator and it is proposed that it should be integrated with the radar spaces in the school's existing navigating bridge.

A typical ship bridge and radar simulator system configuration in mind and intended for SMS is provided in (APPENDIX I). The system utilizes projector boxes and is capable of producing full computer generated imagery (CGI) scenes via a large window display screen located around a compact forward console. The remainder of the bridge area contains other equipment including radars, steering stand, plotting tables and pelorus for visual bearings. A plan view of the installation is also shown in the appendix. The simulator should be capable of meeting all the training objectives and to include the following:

- Pilot house with forward and overhead consoles containing propulsion control, steering and propulsion indicators, anchor controls, speed log, digital clock, ships whistle, communication equipment and wind indicator.

- CGI colour visual scene projected on large window screens; day, dusk and night; clear, haze, fog, 240 degrees horizontal field of view; 35 degrees vertical field of view; landmass navigation and cultural objects; 16 traffic ships.

- Steering stand

- Pelorus

- Two radars and an ARPA

- Remote instructor/control console containing traffic vessel controls; communication equipment; closed circuit TV monitoring of the bridge; audio monitoring of the bridge; general purpose input and display unit; and integrated radar trainer control for the radar trainers.

- Real-time instructional features including readiness tests; several operating modes (e.g. freeze); automated instructor cues; subjective comment entering and keyed recording; various control capabilities.

- Off-line exercise generation capabilities.

- Graphics plotting of exercises.

- Bridge simulator to be located near individual radar trainers to enable students to readily move between bridge and radar trainers on succeeding exercises during a class session.

- System can be configured to permit the radar trainer personnel to operate both the radar and bridge trainers, without the need of new personnel.

- System can be configured for a minimum level of local maintenance support (i.e. sharing of the school's technician); relying on vendor maintenance is too high, experience has showed that the use of instructional and maintenance personnel is estimated to have saved enormous amounts of money, and in one case $80,000.

The most unique aspect of the proposed simulator design in comparison with other ship bridge simulators, is its compact size - bridge viewing area, projector area, system control and monitoring area, and simulation equipment space. The intended bridge configuration to be integrated with the radar trainer installation is believed to achieve significant economy to bring the ship bridge simulator within the necessary budget range.

5.8 Staff training

The operation of a sophisticated instrument such as the simulator equipment for teaching is very complex, and for this reason needs a technically qualified instructor. Personnel who possess professional qualifications (Master and Chief Engineer Foreign Going) do not necessarily have the qualifications to teach and train ship officers on such equipment. Professional qualified personnel who are in the teaching profession still need to undergo a simulation instructor course in order to be fully conversant with the system technology, particularly so in the software configurations.

The realization of theoretical and practical training of future ship officers is connected with highly qualified teaching staff. Therefore simulation based training depends heavily on the instructor's background experience and qualification. The main task of an instructor during simulation based training is the exerting of control over the device and the accessing of information.

In the light of the foregoing and noting comments previously made in sub-chapter 5.1 SMS has to identify the potential simulation instructor early on. It is imperative to train the instructor before the simulation equipment is installed.

5.9 Conclusions

The development of a simulation based training scheme and the acquisition of simulation training equipment is imperative in so far as SMS and the maritime industry in Fiji is concerned. The rapid change in existing shipping technology dictates that sea-going officers must be trained to meet this trend. Therefore the need to train sea-going officers by means of simulation based training at the SMS is very crucial at this point of time.

However the Maritime Administration - Fiji Marine Board has recognized the use of simulators for training seafarers, therefore the SMS has to ensure to take immediate possible steps to acquire this equipment in order to keep Fiji sea-going officers compatible with the rest of the world.

CHAPTER 6

FINAL CONCLUSIONS AND RECOMMENDATIONS

6.1 Final conclusions

The use of marine simulators for training seafarers has increasingly become more universally recognized in the maritime industry. Marine simulators are being used not only in the maritime education and training establishments, but also some shipping companies (e.g. P & O Bulk Shipping Limited) have set up their own simulation training facilities to train their own shipboard personnel.

However, although marine simulators are not yet being made mandatory internationally for training sea-going officers, their development has shown enormous marked positive effect of bridging the gap between the simulated environment and the real world conditions. The radar and Arpa will become mandatory in due course.

The rapid growth and improvement in the ship building architecture has also showed the rapid changing in the simulation technology. Technological training is needed in order to counter the former and to improve the functional training approach of the latter.

The functional approach of training sea-going officers in the traditional manner is considered to be out-of-date and is inadequate to meet the modern technological demand, and for this reason students have to be trained under simulation techniques. The traditional training method, however, cannot be totally ruled out but has to be utilized in parallel with modern day technological training methods.

The talents in the existing simulation world are enormous and training institutions have the advantage to explore and to choose from the many simulation varieties which are presently in existence to meet their training needs. Simulation equipment was quite expensive in earlier days of its inception since there was not much competition and development.

In the latest state of knowledge however, the initial price of simulation equipment is markedly reduced and within the budget range of training institutions. A word of caution has to be noted and that is, experience has shown that all too often a ship or engine simulator has been provided for a customer who then finds it is totally unsuited to his needs. With the above in mind, institution personnel who are directly involved in the future acquisition of simulation equipment have to be fully conversant with the system technology.

The views in some quarters regarding the training of seafarers in the hands-on experience on board ships are still quite strong. It would be desirable to see that potential future ship officers be trained in this manner. It is unfortunate to say that this is very difficult to achieve anymore in the existing modern shipping world due to the trend towards reduced manning scales on ships, meaning it is difficult for shipboard staff to find time to train these future officers.

Acquiring a training ship as noted in sub-chapter 4.6 is too expensive for an institution to cope with, and for this reason, the use of simulators is an alternative to bridge the gap.

It is obvious that simulation based training cannot totally replace the hands-on experience on board ships. However, simulation equipment can be fully utilized in all sorts of training exercises which student officers are unlikely to encounter in real life, particularly in the emergency response situations.

Carrying out these particular training manoeuvres in real world conditions would be dangerous and uneconomical and might jeopardise the lives of personnel, the ship and the environment. All this training can be repeated and done safely in the simulator to prepare potential future ship officers should they encounter such a situation.

The training of simulation instructors is imperative, the qualification of the instructor and the instructional techniques that he employs during training are critical for effective simulator training. Research has shown that the instructor is as important, if not more important, than many simulator fidelity issues, once a minimum level of simulation fidelity is achieved and, transforms the simulator into an effective training device.

Various maritime simulation training institutions around the world have been successful over the years in selecting individuals as instructors for their respective training programs. In addition, each training institution has had experience in selecting instructors for radar simulator training. Much of this experience will be valuable when selecting individuals to serve as instructors for the shiphandling and ship bridge simulator training.

The Standards of Training, Certification and Watchkeeping (STCW/78) Convention is currently under review and will culminate in an International Diplomatic Conference in mid 1995 as earlier noted in sub-chapter 4.1 and 4.7.

In the reviewing process of the convention by IMO's Sub-Committee on Standards of Training and Watchkeeping (STW/26) held in July 1994 which the author attended, major issues such as the auditing of the quality of maritime training, examinations and assessments, and of the administrations of national certificate systems was discussed in length. These issues have been documented and will be included in the regulation of the Annex to the Convention and Section of the Code.

The provisions of the Annex to the Convention and Section of the Code, will provide the necessary flexibility for the quality standards to be applied to systems of varying sophistication according to the operational needs of the industry, the particular requirements of the administration and also facilitate and encourage the application of new technology.

Noting the above provisions, training institutions have to ensure that appropriate training equipment is acquired in order to fulfill the convention requirements, particularly for the developing countries such as Fiji as it is envisaged that the trend of training ship's personnel is towards the functional approach.

Regarding the acquisition of simulators for SMS as previously noted in sub-section 5.1, donor countries have to be approached in order to secure funding. Australia and

Japan are identified to be the potential donors for procurement. These donor countries will only assist SMS provided that the schools' development plans for the maritime sector also help other regional countries.

To substantiate the above, it is proposed that SMS organize a two day symposium to be held at the Forum Secretariat Head Quarters in Suva, Fiji, inviting Heads of Schools from neighbouring regional countries to attend. The purpose of this proposed meeting is to establish an agreement between regional countries that the simulation equipment to be acquired will be used not only for Fiji but will cater for all regional students. A memorandum of understanding will be signed by all members.

It is proposed that the above symposium be organized as soon as possible, preferably in February 1995. SMS is to approach the Japan International Corporation Assistance (JICA) for the possible funding of a two day conference.

As previously noted, the acquisition of simulation training equipment is imperative in so far as the SMS is concerned. Therefore it is proposed that this equipment should be installed as soon as possible and preferably by late 1995. Simulation training programs should be implemented in the beginning of the 1996 academic year.

Simulation equipment intended for SMS has been identified in sub-sections 5.7.1 and 5.7.2. It is proposed that a centralised instructor's console and four own ships be acquired, one with a visual scene which utilizes projector boxes with seven channels, and capable of producing 240 degrees horizontal FOV and 35 degrees vertical FOV. The remaining three own ships are to be used for blind pilotage. All relevant hardware and software to be provided should have the capabilities of further in-house development.

The radiotelephony will be phased out soon and will be replaced by the Global Maritime Distress and Safety System (GMDSS) which will come into force world wide by 1st February, 1999. It is strongly emphasized that full GMDSS simulation equipment capable of covering all four sea areas be acquired. Four work stations are required for this system and should be integrated into all four own ships.

6.2 Recommendations

Pursuant to the above conclusions, it is recommended that the following steps are taken:

- The Fiji School of Maritime Studies (SMS) approach donor countries through their respective Embassies for the procurement and funding of simulation equipment with full support from the Fiji Government - Ministry of Education, Science and Technology, and the Ministry of Foreign Affairs.

- SMS immediately prepare all plans and relevant documentation for the acquisition of simulation equipment and to be transmitted to respective Embassies for assessment purposes.

- At least two potential simulation instructors holding the highest professional certificate of competency be identified by the school. These instructors should undergo a four weeks specialized training course provided by the manufacturer of the simulator.

- A potential competent technician is to be identified by SMS and be trained by the simulator manufacturer. This particular personnel is very important and should be trained to maintain correct and carry out minor repairs.

- The school of maritime studies give the simulation instructors the opportunity to participate in the International Conference on Marine Simulation (MARSIM) to enable exchange information in terms of simulation training and to enhance their performance in conducting training courses on the simulator.

- Every two to three years simulation instructors should be given the opportunity to go on board ships for at least three months in order to upgrade their knowledge and to enhance their practical skills in shiphandling operations.

- Opportunity in the use of the simulation facilities should be given to pilots and VTS operators for training and other needs which may be required by the industry.

- The Fiji School of Maritime Studies should become a member to the International Marine Simulator Forum (IMSF). This is to enable the school to keep abreast with the latest and the likely future development of simulation equipment around the world.

- The existing navigating bridge of the school should be completely renovated for the purpose of accommodating all simulation training equipment.

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APPENDIX: A

Types of simulators:

Some of the types of simulators in use in the maritime and related industries are listed below. However this list is not complete and new additions occur regularly:

(i) navigation equipment simulator
(ii) communication equipment simulator
(iii) radar simulator
(iv) radar navigation simulator
(v) shiphandling simulator
(vi) full mission shiphandling simulator
(vii) fisheries simulator
(viii) inland waterway ship simulator
(iv) dynamic positioning simulator
(x) liquid cargo simulator
(xi) ballast control simulator
(xii) dredging ship simulator
(xiii) propulsion plant simulator
(xiv) steam generation plant simulator
(xv) electric power plant simulator
(xvi) refrigeration plant simulator
(xvii) oilspill management trainer
(xviii) vessel traffic management trainer
(xix) offshore process control simulator
(xx) drilling technology simulator

Source: Norcontrol, 1994.

APPENDIX: B

IMSF DRAFT CLASSIFICATION SYSTEM

MARINE OPERATION SIMULATORS

Classification : FULL MISSION

BRIDGE (Navigation & Procedures)	ENGINE (Propulsion and power plant)	CARGO & BALLAST (Liquid & Dry)
Real bridge with controls/instruments providing auditory and visual cues, motion cues and effects for ship operations in all conditions.	Real control room and simulated engine room operation with the use of all local and mimic panels for the operation of all propulsion systems generally available on the installation being simulated.	Real control room with motion in the transverse and longitudinal axes, vibrator and audio cues, providing computerized and manual controlled access to all operational systems.

Source: A report by IMSF Classification Working Group (CWG), Vestfold, Norway, August 15-19, 1994.

APPENDIX: B (Cont')

MARINE OPERATION SIMULATORS

Classification : MULTI-TASK

BRIDGE (Navigation & Procedures)	ENGINE (Propulsion and power plant)	CARGO & BALLAST (Liquid & Dry)
Bridge representation with real or facsimile control instruments, providing visual cues for operations in selected conditions.	Control room and engine room operation representation without the use of local and mimic panels for the operation of all propulsion systems and sub-systems. Audio and visual cues providing computerized controlled access to all operation systems generally available on the installation being simulated.	Control room representation providing computerized and manually controlled access to all operating systems.

Source: A report by IMSF Classification Working Group (CWG), Vestfold, Norway, August 15-19, 1994.

APPENDIX: B (Cont')

MARINE OPERATION SIMULATORS

Classification : LIMITED TASK

BRIDGE (Navigation & Procedures)	ENGINE (Propulsion and power plant)	CARGO & BALLAST (Liquid & Dry)
A partial bridge for selected operations.	Control room and engine room operation with/without the use of local and mimic panels for the operation of most propulsion systems and sub-systems. Audio and visual cues providing computerized and/or local controlled access to operational systems generally available on the installation being simulated.	A partial control room for selected operations.

Source: A report by IMSF Classification Working Group (CWG), Vestfold, Norway, August 15-19, 1994.

APPENDIX: B (Cont')

MARINE OPERATION SIMULATORS

Classification : SINGLE TASK

BRIDGE (Navigation & Procedures)	ENGINE (Propulsion and power plant)	CARGO & BALLAST (Liquid & Dry)
Single item of equipment for a particular task.	Specific control room or engine room operation with/without the use of local and mimic panels for the operation of specific propulsion systems and sub-systems. Audio and visual cues providing computerized and/or local controlled access to the operational system. all other systems may be isolated or "fixed" to have no affect on the operation of the installation.	Single item of equipment for a particular task.

Source: A report by IMSF Classification Working Group (CWG), Vestfold, Norway, August 15-19, 1994.

APPENDIX: C

The proposed simulation training program for the various deck apprentice course are as follows:

DECK APPRENTICE STAGE ONE (DA1).

CLASSROOM	SIMULATOR	FEEDBACK	TEACHING TECHNIQUE
Discussion and lecture to meet unique objectives.	Familiarization on bridge equipment and shipboard terminology. Practice on the fundamental principles of vigilant lookout.	During the simulator exercises, the instructor supervises and makes recordings for later discussion.	Classroom - Problem solving discussion and lecture.

Source: Simulators for Mariner Training and Licensing, Volume II, July, 1980.

APPENDIX: C (Cont')

DECK APPRENTICE STAGE THREE (DA3).

CLASSROOM	SIMULATOR	FEEDBACK	TEACHING TECHNIQUE
Discussion and lecture to meet unique objectives. Lectures on basic ship handling.	Practice of bridge procedures. Steering tests. Fix ships' position by various means. Fundamental principles of shiphandling.	Training exercises can be stopped and or completely replayed for evaluation and discussion. Freeze Record Playback	Simulator - Hands on Critique - discussion of exercises.

Source: Simulators for Mariner Training and Licensing, Volume II, July, 1980.

APPENDIX: C (Cont')

DECK APPRENTICE STAGE FIVE (DA5).

CLASSROOM	SIMULATOR	FEEDBACK	TEACHING TECHNIQUE
Discussion and lecture to meet unique objectives. Lectures on ship manoeuvring.	Bridge and navigational procedures. Manoeuvre the vessel in various exercise situations. Turning circle, Advance and Transfer, Williamson turn, Effect of current and wind.	Analysis of the completed exercise and subsequent discussions.	Classroom - Lecture Simulator - Post problem critique - instructor and student discussions.

Source: Simulators for Mariner Training and Licensing, Volume II, July, 1980.

APPENDIX: D

Training objectives for the watchkeeper (Deck Apprentice) simulation training course:

DECK APPRENTICE STAGE ONE : On completion of the training course the trainee should be able to:

- effectively communicate verbally with other shipboard personnel using proper shipboard terminology.
- correctly operate and utilize each piece of equipment normally found on the bridge of a commercial vessel (e.g. gyro compass, helm, engine order telegraph, radar).
- demonstrate an understanding of the use of masthead and sidelights to assist in determining traffic vessel aspect.
- demonstrate an understanding of the use of visual bearings in establishing and assessing risk of collision.
- use a visual bearing circle, telescopic alidade, or pelorus to determine contact bearing and contact bearing drift.
- demonstrate an understanding of the effect of weather (i.e. wind, current, seas) on shiphandling and course keeping characteristics.
- demonstrate the ability to maintain a vigilant lookout in accordance with standing orders and normal routine, monitoring internal and external situations for potential problems or hazardous situations that may put the vessel or personnel in jeopardy and take appropriate action to assure that safe conditions exist.

APPENDIX: D (Cont')

<u>DECK APPRENTICE STAGE 3</u> : On completion of the training course the trainee should be able to:

- demonstrate an understanding of fundamental shiphandling principles (e.g. turning circles, advance and transfer).
- demonstrate an understanding of the effect of weather (i.e. wind, current, seas) on shiphandling and course keeping characteristics.
- determine "safe speed" under a variety of operational conditions (e.g. reduced visibility).
- layout and interpret dead reckoning tracklines on a chart under operational watch conditions.
- analyse a dead reckoning track for potential navigational hazards under operational watch conditions.
- visually identify charted objects suitable for visual lines of position under both day and night operational watch conditions.
- determine vessel position by means of visual fixes under both day and night operational watch conditions.
- determine vessel position by means of radar fixes under operational watch conditions.
- compare the new fix position (e.g. radar, visual) with the charted DR position, evaluate discrepancies and establish present position under operational watch conditions.
- determine compass error using charted ranges under operational watch conditions.
- determine, plot, and evaluate the vessel's position by utilizing any of the following systems under operational watch conditions: LORAN, OMEGA, DECCA, GPS.

- determine, plot, and evaluate a radio direction finder line of position under operational watch conditions.
- utilize a line of soundings to assess the accuracy of his navigational position information under operational watch conditions.
- demonstrate the ability to maintain a vigilant lookout in accordance with standing orders and normal routine, monitoring internal and external situations for potential problems or hazardous situations that may put the vessel or personnel in jeopardy and take appropriate action to assure that safe conditions exist.
- demonstrate the ability to notify the master of all navigational hazards which may impact the safety of the vessel (e.g. shipboard engineering casualties, heavy weather).
- demonstrate the ability to notify the master in accordance with the standing orders of the occurrence of anticipated events (e.g. landfall).
- demonstrate the ability to instruct/supervise as appropriate other members of the bridge watch in their duties and responsibilities (e.g. helmsman, lookout).
- demonstrate the ability to issue/verify appropriate helm orders using proper terminology in order to safely navigate ownship.

<u>DECK APPRENTICE STAGE 5</u> : On completion of the training course the trainee should be able to:

- demonstrate an understanding of the function, operation, and limitation of radar as regards collision avoidance.

- demonstrate an understanding of relative motion concepts including manoeuvring board and rapid radar plotting techniques.
- demonstrate an understanding of the use of masthead and side lights to assist in determining traffic vessel aspect.
- demonstrate an understanding of the use of visual bearings in establishing and assessing risk of collision.
- accurately maintain a radar plot of multiple contacts simultaneously under operational watch conditions.
- accurately assess each contact's potential for risk of collision and filter contacts with low risk of collision under operational watch conditions.
- accurately determine contact CPA, course, speed, etc., utilizing either manoeuvring board or rapid radar plotting techniques under operational watch conditions.
- properly recognize, interpret, and evaluate visual contacts as to type, aspect, and relative motion under operational watch conditions.
- use of a visual bearing circle, telescopic alidade, or pelorus to determine contact bearing and contact bearing drift.
- integrate available information and apply the Rules of the Road to a particular situation under operational watch conditions.
- manoeuvre ownship to pass at a safe distance, according to the procedures outlined in the Rules of the Road and the master's standing/night orders.
- demonstrate an understanding of fundamental shiphandling principles (e.g. turning circle, advance and transfer).

APPENDIX: D (Cont')

- demonstrate an understanding of emergency shiphandling principles (e.g. Williamson turn, crash stop).
- determine "safe vessel speed" under a variety of operational watch conditions (e.g. reduced visibility).
- properly monitor the appropriate radio telephone frequencies under operational watch conditions.
- properly transmit/receive the following types of messages via radio telephone: distress, urgency, safety.
- demonstrate the ability to maintain a vigilant lookout in accordance with standing orders and normal routine, monitoring internal and external situations for potential problems or hazardous situations that may put the vessel or personnel in jeopardy and take appropriate action to assure that safe conditions exist.
- demonstrate the ability to notify the master accurately and concisely of traffic vessels with possible risk of collision, as defined by the standing order criteria, under operational watch conditions.
- demonstrate the ability to orally communicate with other mates concerning the status of the vessel during watch relief.
- demonstrate the ability to instruct/supervise as appropriate other members of the bridge watch in their duties and responsibilities (e.g. helmsman, lookout).
- demonstrate the ability to issue/verify appropriate helm orders using proper terminology in order to safely navigate ownship.

Source: Functional Specifications and Training Program Guidelines for a Maritime Cadet Simulator, Washington D.C., Dec. 1982.

APPENDIX: E

Proposed ship simulator training program of officers-in-charge of the navigational watch.

CLASSROOM	SIMULATOR	FEEDBACK	TEACHING TECHNIQUE
Discussions and lectures to meet unique objectives.	Encounters with emergency conditions coupled with routine and more critical navigational constrictions or hazards. Development of a bridge management team as an effective unit. Interaction of ship, dynamics and channel. Manoeuvre the vessel in various exercise situations.	Analysis of the completed exercise and subsequent discussions.	Classroom - lecture Simulator - Post problem - critique instructor and student discussions.

Source: Simulators for Mariner Training and Licensing, Volume II, July, 1980.

APPENDIX: F

SHIP SIMULATOR TRAINING OF OFFICERS-IN-CHARGE OF THE NAVIGATIONAL WATCH

1. TRAINING OBJECTIVES:

(a) Keep a safe navigation watch when underway in clear and restricted visibility:

- maintain a look-out both visually and by other means.
- con the ship by giving orders to the helmsman and by control of the automatic pilot.
- ascertain the risk of collision and take appropriate action in clear and restricted visibility.
- ascertain the ship's position by both visual and other means.
- set a course to reach a point in conditions of current and wind.
- understand the manoeuvring data supplied to the ship and apply this knowledge to:
    - controlling a reduction in speed.
    - bringing the ship to a single anchor.
    - executing emergency manoeuvres, emergency stopping manoeuvres and man overboard manoeuvres.
    - executing an alteration of course so as to maintain the planned track.
- use of VHF radio for obtaining and exchanging navigational information.
- use internal communication for instructing other crew members and calling the master.

(b) Participate as member of the Bridge Team:

- plan a passage;
- understand standing orders;
- support the Master and Pilot;
- monitor the position of the ship;
- monitor equipment.

2. <u>TRAINING METHODOLOGY:</u>

(a) The ship simulator training will follow formal theoretical instruction in all the objectives of the course. This instruction will preferably have included radar/navigation simulator training in position fixing, track keeping, collision avoidance and passage planning.

(b) The length of the course will be determined by the scope and level of the preparatory instruction and the attainment levels reached.

(c) The number of persons attending the program of training shall be such that:

- not more than four students shall be on the bridge during the conduct of a "student-in-charge" exercise.

- each student shall be involved in a minimum of 32 hours of simulation exercises.

- each student shall be in charge of the bridge for a minimum of 8 hours simulation time.

(d) Prior to the commencement of each exercise, students will be fully briefed on the objectives of the exercise, the roles they will play and the standards of performance expected of them.

Each exercise will be followed by a de-briefing which will analyse the performance of the exercise, identify weaknesses and provide instruction on how these weaknesses should be overcome.

(e) The effectiveness of the training shall be assessed by objectives measurement of performance, such as:

- ability to maintain a track;
- ability to avoid collision;
- ability to arrive at a specified position at a required speed or at a specified time;
- monitoring of performance so as to detect a deviation from the planned track or a malfunction of equipment;
- observance of good seamanship.

Source: P.Muirhead, WMU, 1994. Simulation systems & Training methodology course notes.

APPENDIX: G

SHIP SIMULATOR TRAINING PROGRAM FOR SHIP MASTERS

CLASSROOM	SIMULATOR	FEEDBACK	TEACHING TECHNIQUE
Discussions and lectures to meet unique objectives. Lectures on ship manoeuvring. Information on the manoeuvring characteristics of the ship used during simulation.	Exposure to new port prior to actual ship navigation. Manoeuvre the ship in confined waters. Fog/heavy traffic/night time port operations.	Discussions on executed navigational task or manoeuvring problem.	Classroom - lecture Simulator - Hands on, and Post problem critique.

Source: Simulators for Mariner Training and Licensing, Volume II, July, 1980.

APPENDIX: H

SHIP SIMULATOR TRAINING OF SHIP MASTERS

1. TRAINING OBJECTIVES

(a) Command the navigation of the ship:

- prepare and execute a detailed passage plan in restricted waters and in areas effected by traffic separation schemes.

- optimize the best use of manpower for the conduct of a passage.

- respond safely and expeditiously to forced alterations to a passage plan and to emergency situations.

(b) Manoeuvre the ship in confined waters:

- understanding the manoeuvring data supplied to the ship, the principles of shiphandling and the effects of wind, current, shallow water, banks and of passing ships and apply this knowledge to:

- controlling the position, heading and speed of the ship while picking up or dropping a pilot.
- selecting and bringing the ship to a safe anchorage.
- controlling the passage of a ship in a narrow channel.
- turning and berthing a ship with and without the aid of tugs.
- mooring a ship to a buoy.

- unberthing and unmooring a ship.
- using tugs without danger to the tugs and to assist the ship.

2. TRAINING METHODOLOGY :

(a) The ship simulator training will follow formal theoretical instruction in all the objectives of the course. This instruction will have included radar/navigation simulator training in passage planning and execution and in collision avoidance in restricted waters, including those in which traffic separation schemes are in operation and in heavy traffic.

Part (b) of the objectives may be preceded by instruction and hands-on experience on a part task trainer for the manoeuvring of ships.

(b) The length of the course will be determined by the scope and level of the preparatory training and attainment levels reached.

(c) The numbers of persons attending the program shall be such that:

- not more than three students are on the bridge during the conduct of a "student-in-charge" exercise.

- for Part (a) of the objectives, each student shall be involved in a minimum of 12 hours of practical simulation and have been in command for at least 4 hours of that time.

APPENDIX: H (Cont')

- for Part (b) of the objectives, each student shall be involved in a minimum of 30 hours of practical simulation and have been in control of the ship for at least 10 hours.

(d) The series of exercises shall be in ascending stages of difficulty recognizing the total lack of practical experience in these matters (particularly those covered in Part (b) of the objectives) by most students. While students can learn from the observation of others, they do not gain the skills of command and ship manoeuvring unless personally in control of the ship.

(e) Prior to the commencement of each exercise, students will be fully briefed in the objectives of the exercise, the roles they will play and the standards of performance expected of them.

Each exercise will be followed by a de-briefing which analyses the performance of the exercise, identifies weakness and provides instruction on how these weaknesses can be overcome.

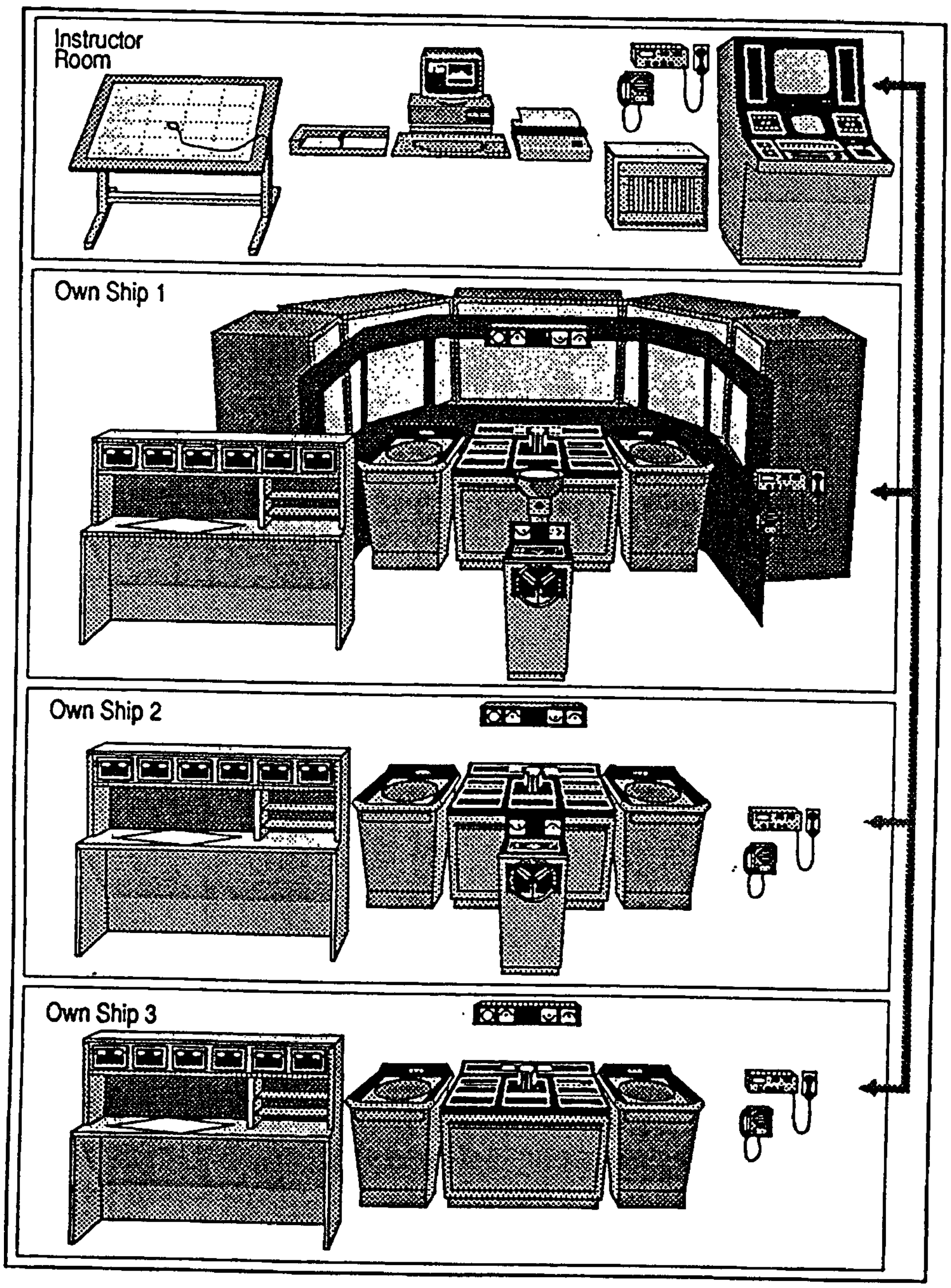
(f) The effectiveness of the training shall be assessed by objective measurement of performance, such as:

- ability to control the safe passage.
- ability to control the longitudinal and lateral movement of the ship while manoeuvring and berthing.

Source: P.Muirhead, WMU, 1994. Simulation systems & Training methodology course notes.

APPENDIX: I

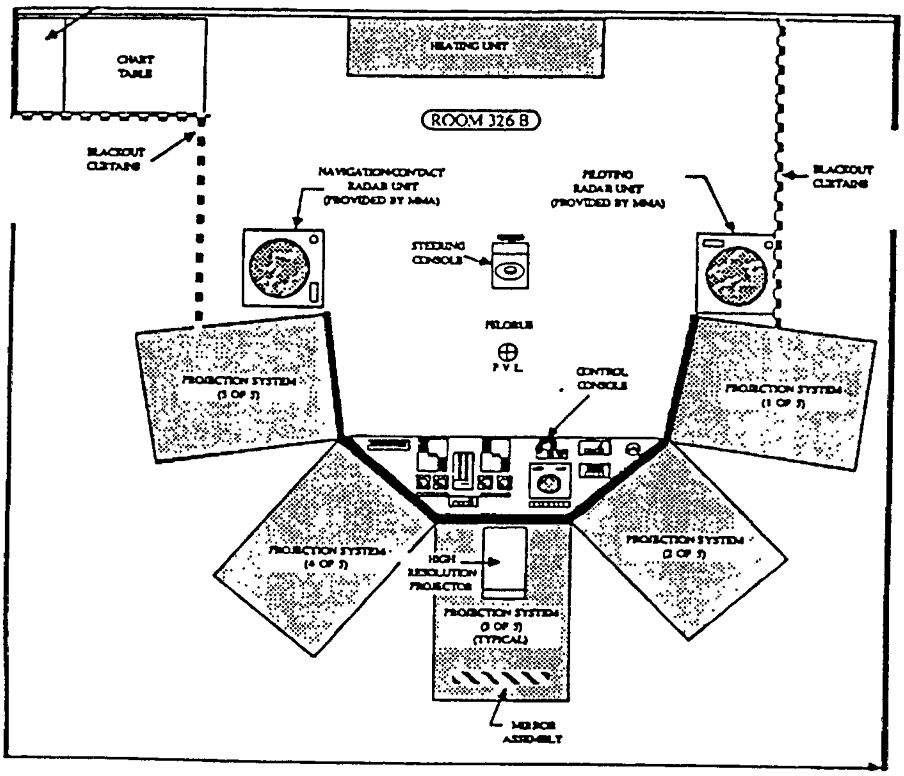
Proposed simulation training equipment for SMS



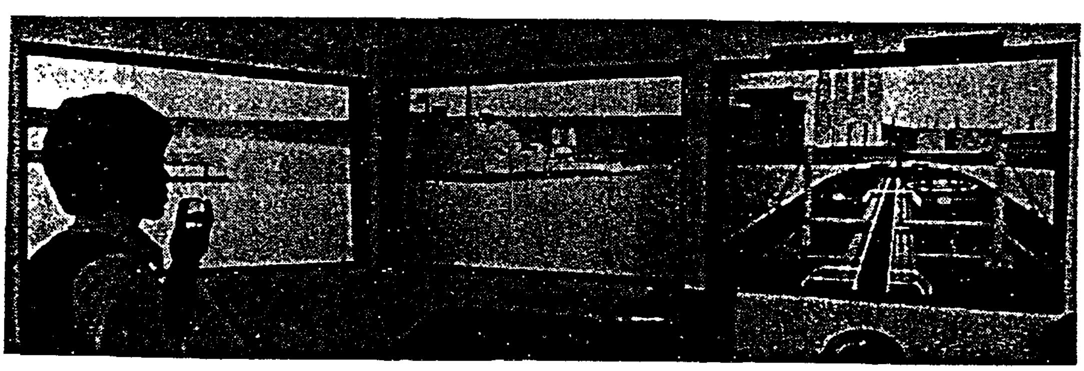
Source: Norcontrol

APPENDIX: I (Cont')

Proposed simulation training equipment for SMS



Plan View of the proposed system

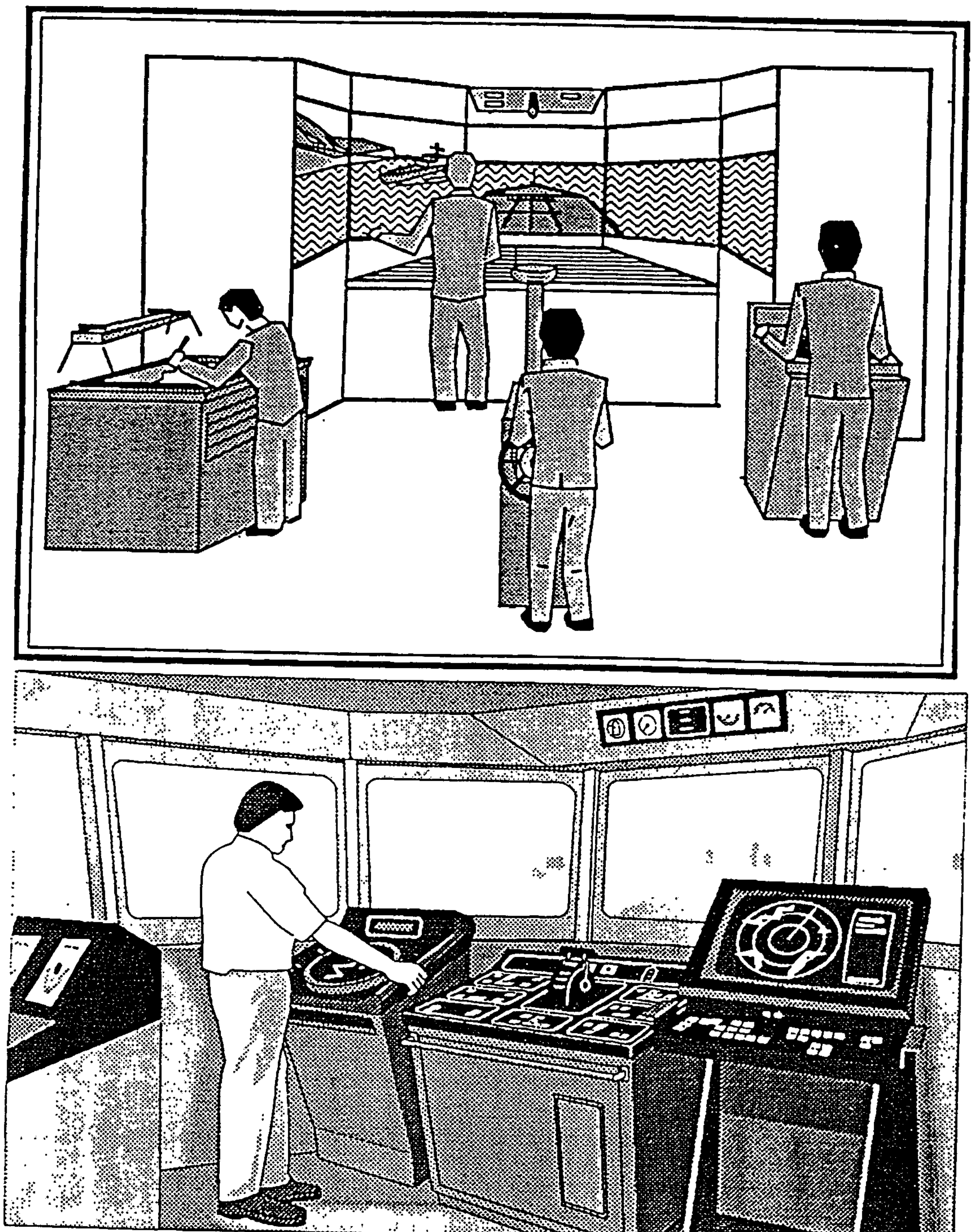


Screen View of the proposed system

Source: Hammel T.J. & Motte G. (MARSIM 1987), Shiphandling simulator design for Nautical Schools.

APPENDIX: I (Cont')

Proposed simulation training equipment for SMS



Typical Configurations of the proposed system

Source: Norcontrol, 1994.

APPENDIX: J

SHIPHANDLING SIMULATORS (VISUAL CAPABILITY)

No	Name & location	Year	Type	Manufacturer
1*	SSPA, Goteborg, Sweden	1967	CGI/TV	SSST
2*	SMS, TNO-Delft, N'lands	1968	S/graph	IWECO-TNO
3*	MARIN, Wageningen, N'lands	1969	S/graph	IWECO-TNO
4	SSS, Hiroshima Uni, Japan	1988	CGI	University[1]
5*	Bremen Poly, W.Germany	1975	S/proj	VFW-Fokker
6	IHI, Tokyo, Japan	1992	CGI	IHI/NAC[2]
7*	SHS, Osaka Uni, Japan	1975	S/graph	University
8*	Navy, DenHelder, N'lands	1975	Nocturn	Navy
9*	TNO-Soesterberg, N'lands	1976	M/board	TNO
10	CAORF,K.Pt, NY, USA	1976	CGI	Sperry
11*	Marine Safety Int,NY,USA	1976	M/board	Sperry
12*	MARIN,Wageningen, N'lands	1976	Nocturn	TNO
13*	Warsash College, S'Ton,UK	1977	Nocturn	Decca[3]
14*	TUMM, Tokyo, Japan	1983	CGI	NAC/Uni[4]
15	Bremen Poly, W.Germany	1978	Nocturn	VFW-Fokker
16*	Mitsubishi,Nagasaki,Japan	1978	S/proj	MHI
17	N.Stonington, USA	1979	CGI	Ship Analytic
18*	SMS Trondheim, Norway	1979	Nocturn	VFW-Fokker
19*	Danish Mar.Inst,Lingby	1980	CGI/TV	DMI
20	Warsash College,S'Ton, UK	1981	Nocturn	Decca
21	MIGAS, Baltimore, USA	1981	Nocturn	VFW-Fokker
22	Shipsim,S.Shields Colge,UK	1982	Nocturn	Decca
23*	CASSIM,UWIST Cardiff,Wales	1982	CGI/Tepi	Marconi/Decca[5]
24	SUSAN,Hamburg, W.Germany	1982	CGI	Krupp Atlas
25	Shipsim,Glassgow,Scotland	1982	Nocturn	Decca
26*	SMS, Trondheim, Norway	1982	S/proj	VFW-Fokker
27	RSSC, Leningrad, USSR	1983	Nocturn	Norcontrol
28	Marin, Wageningen, N'lands	1983	CGI/Grph	TNO
29	Toledo, Ohio, USA	1983	CGI	Ship Analytic
30	Navy, Sydney, Australia	1985	CGI	Krupp Atlas

APPENDIX: J (Cont')

No	Name & location	Year	Type	Manufacturer
31	AMC,Launceston,Australia	1985	CGI	Krupp Atlas
32	TUMM, Kobe, Japan	1985	CGI	na
33	Taiwan Mar.College, Taiwan	1985	CGI	Krupp Atlas
34	Piney Point,Maryland,USA	1985	CGI	Ship Analytic
35	USCG,New London,Ct,USA	1985	CGI	Ship Analytic
36	Finsim, Espoo, Finland	1986	CGI	Racal/Marconi
37	MTC, Ashiya, Japan	1986	CGI	MTC
38	Navy, Kiel, W.Germany	1987	CGI	Krupp Atlas
39	Plymouth Polytechnic, UK	1987	CGI	Racal/Decca
40	Ship,Res.Inst,Tokyo,Japan	1988	CGI	na
41	Korean Mar.T.I.Pusan,Korea	1988	CGI	Norcontrol
42	FETI Vladivostok Russia	1989	CGI	Norcontrol
43	Petropavlovsk Russia	1989	CGI	Norcontrol
44	InstitutoOsservatori Genoa	1989	CGI	Sindel
45	Nova Scotia N/Inst Canada	1989	CGI	Norcontrol
46	ENMM St Malo France	1989	CGI	Norcon/Thomson
47	Sakhalin Shipping Co Russia	1989	CGI	Norcontrol
48	Chabahar Iran	1989	CGI	Norcontrol
49	Bulgarian MTI, Bulgaria	1990	CGI	Norcontrol
50	Haugesund MarCollegeNorway	1990	CGI	Norcontrol
51	NIOC Teheran Iran	1990	CGI	Norcontrol
52**	Danube Shipping Co, Russia	1990	CGI	Norcontrol
53	Danish Mar.Inst,LngbyDmark	1990	CGI	Norcontrol
54	KMTRC Korea	1990	CGI	Ship Analytic
55	Inst.TecnicoNauticoVenezia	1990	CGI	Sindel
56	Kesen Inst. Piraeus,Greece	1990	CGI	Sindel
57	Sakhalin ship Co, Russia	1991	CGI	Norcontrol
58	State University NY	1992	CGI	Norcontrol
59	Seamans Ch.Inst, NY, USA	1992	CGI	Norcontrol
60	MSCN, Wageningen, N'lands	1992	CGI	MSCN
61	Marine Inst,N.F.Land,Can	1992	CGI	Norcontrol
62	Vestfold Poly,Tonsberg,Nor	1992	CGI	Norcontrol

APPENDIX: J (Cont')

No	Name & location	Year	Type	Manufacturer
63	World Trade Centre S/pore	1992	CGI	Norcontrol
64	Indian Navy Bombay	1992	CGI	Ship Analytic
65	Kotha, Finland	1992	CGI	Sindel
66	SMS Trondheim Norway	1992	CGI	Norcontrol
67	Britania RNC UK	1992	CGI	Norcontrol
68	NAROV Curacao	1992	CGI	Norcontrol
69	Maine Maritime Academy USA	1992	CGI	Norcontrol
70	Inst.Tecnico Nautico PalermoIt	1992	CGI	Sindel
71	Kotka Inst.Naut StudiesFinland	1992	CGI	Sindel
72	Yusen Marine Sc Tokyo Japan	1992	CGI	Yusen
73	Kalmar Marine Academy Sweden	1993	CGI	Norcontrol
74	Nizhny Novgorod Russia	1993	CGI	Norcontrol
75	Far Eastern T.I. Vladivostok	1993	CGI	Norcontrol
76	Mariehamn Finland	1993	CGI	Norcontrol
77	STC Sydney Australia	1993	CGI	Norcontrol
78	Port of Singapore, Singapore	1993	CGI	Norcontrol
79	State Uni.St Petersburg Russia	1993	CGI	Norcontrol
80	Southampton Inst.H.E. UK	1993	CGI	Norcontrol
81	W.JapanDynamicsInstSasebo Jap	1993	CGI	na
82	Star Centre Dania,Florida USA	1993	CGI	Norcontrol
83	MSTC Terschelling, N'lands	1993	CGI	MSCN
84	SMS Trondheim	1993	CGI	Norcontrol
85	FMSS Navy, Brazil	1993	CGI	Ship Analytic
86	Panama Canal Commssion Panama	1993	CGI	Ship Analytic
87	Tromso College Norway	1993	CGI	Norcontrol
88	STAR Toledo, Ohio USA	1993	CGI	Norcontrol
89	WSM Szczecin Poland	1994	CGI	Norcontrol
90	PDV Marine Venezuela	1994	CGI	Norcontrol
91	MSR Rotterdam	1994	CGI	MSI
92	Turkish Navy	1994	CGI	Ship Analytic
93	HMS Dryad Portsmouth UK	1994	CGI	Norcontrol
94	West Coast STAR Seattle USA	1994	CGI	Norcontrol

APPENDIX: J (Cont')

No	Name & location	Year	Type	Manufacturer
95	US Navy, San Diego	1994	CGI	MSI
96	Bombay, India	1994	CGI	Ishikawajimi HI
97	R.T.Navy, Thailand	1994	CGI	Atlas Electronic
98	Volgo Tanker Co Russia	1994	CGI	Norcontrol
99	CCG, Sydney NS Canada	1994	CGI	Norcontrol
100	Danish Mar.Inst,Denmark	1994	CGI	Norcontrol/DMI
101	RNN, Den Helder, N'lands	1994	CGI	MSCN
102	Singapore Water Police	1995	CGI	Ship Analytics
103	AMTA, Alexandria, Egypt	1995	CGI	Ship Analytics

Source: P.Muirhead WMU August 1994

* Simulators thus marked have since been replaced by Computer Generated Imagery (CGI) system or closed down. In recent years a number of radar and navigation simulators have been provided with add-on visuals to one or more of the own ship cubicles.

** Simulators thus marked is a riverboat simulator.

Notes.

1. 1971 Film projection system replaced in 1988 with a CGI based system
2. 1975 slide projection system replaced in 1992 with a CGI based system
3. This first Warsash nocturnal simulator was closed down in 1993
4. 1974 shadowgraph system was replaced in 1983 with a CGI based system
5. Closed down in 1985.