WORLD MARITIME UNIVERSITY

Malmö, Sweden

SHIPHANDLING SIMULATOR
A PROPOSED SHS TRAINING PROGRAM FOR VIETNAM MARITIME UNIVERSITY

By

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Vietnam

A dissertation submitted to the World Maritime University in partial fulfillment of the requirements for the award of the degree

MASTER OF SCIENCE

in

MARITIME EDUCATION AND TRAINING (NAUTICAL)

Year of Graduation

1993

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 views, and are not necessarily endorsed by the University.

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To my parents

ACKNOWLEDGEMENT

For the successful completion of this dissertation, I am indebted in various degrees to such a large number of people that it is impossible to list here all their names and roles.

I wish to express my heartfelt thanks and sincere appreciation to my Government and my employer, Vietnam Maritime University, for giving me the rare opportunity to undertake this two-year fellowship at the World Maritime University.

Special thanks to my sponsors, SIDA (Swedish International Development Authority) for selecting me as one of their recipients of sponsorship. Their Fellowship guaranteed my continuous two years of studies at this Institution, a rare and valuable opportunity, and a unique experience in my life.

My profound gratitude goes to Prof. Le Duc Toan, the Rector of Vietnam Maritime University, for kindly nominating and supporting me to do the course at the World Maritime University.

The completion of this dissertation was only possible through the kind support, assistance and encouragement given throughout the exercise by many advisors, associates, colleagues and organizations.

I am extremely grateful to my former course professor, Prof. Gunther Zade who advised and provided me with valuable documents for this dissertation.

I feel immense pleasure to offer my sincere and deepest gratitude to my course professor, Prof. Peter Muirhead who with guidance, support and encouragement patiently worked hard with me during the process of this dissertation. He left no stone unturned to make me a better educated person than before.

My special appreciation and particular gratitude goes to Prof. Jens Froese who, in spite of his busy schedule, kindly agreed to co-assess this paper. During his week at WMU as a Visiting Professor and also at home in FHS Hamburg, he checked, corrected, advised and commented on this work.

For the kind, prompt and generous supply of requested material on their procedures, my sincere thanks goes to :

. Capt. Stephen J. Cross, Senior Marine Advisor of Marine Simulator Group at Norcontrol simulation, who was a resident lecturer and is now a Visiting Lecturer of WMU.

. Capt. Donald J. Ferguson, USMS, commandant of midshipmen at US Merchant Marine Academy, Kings Point, who is a Visiting Professor of WMU.

I would also like to convey my sincere gratitude to Atlas Electronic, Bremen, Germany; Norcontrol Simulation, Horten, Norway; and especially to SUSAN, Fachhochschule, Hamburg, Germany; for their warm welcomed during our study visit and for providing me with valuable materials.

If this dissertation has any appreciation, it owes a great deal to a number of resident and visiting professors, and particularly the Librarian and English language staff. I am indebted to Mr Clive Cole, the resident lecturer of English, for kindly and patiently correcting my paper.

I would like to acknowledge, with thanks, all the staff and personnel of WMU for their co-operation and valuable assistance.

I wish to thank all of my classmates of MET(N)-93, who are among the best I have ever had.

In my family, I owe a special debt of gratitude to my parents who have always provided me with the necessary moral assistance and encouragement. My thanks also goes to my brother and my sisters who contributed greatly in the successful completion of my two-years of study with their affection and encouragement.

Finally, I wish I could have mentioned by name all my friends to whom I also owe so much gratitude.

ABSTRACT

This dissertation is a study of the shiphandling simulator (SHS) as an effective training facility at maritime academies and gives a proposed shiphandling training programme for Vietnam Maritime University (VMU).

A brief introduction of VMU's education and training system is given. In order to keep up with and improve the standards of Vietnamese mariners as required by IMO - STCW 78, the need to install a SHS at Vietnam Maritime University is examined.

The growth and development of shiphandling simulators is investigated. The concept of the shihandling simulator is identified. The advantages and disadvantages of shiphandling simulator and its design considerations are examined from the user's point of view.

The exploration of simulation training philosophies and shiphandling simulator training programmes developed in selected training centres provides the most effective way of utilising the training facility.

The result from this research has led to the design of a proposed shiphandling simulator training programme. The training programme is integrated within the current syllabus at VMU.

The final chapter is a summary of the aspects of a shiphandling simulator and its training programme. A number of recommendations are made concerning the need for improving the training of mariners by utilising shiphandling at VMU.

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LIST OF ABBREVIATIONS

AG	Kapitan Auf Grösser Fahrt. (Master Certificate Unlimited).
AGW	Wachoffizier Auf Grösser Fahrt. (Watchkeeper Certificate Unlimited).
AMC	Australian Maritime College.
ARPA	Automatic Radar Plotting Aid.
BWS	Bridge Wing Simulator.
CAORF	Computer Aided Operations Research Facility.
CAS	Collision Avoidance System.
CGI/C.G.I.	Computer Generated Image.
CRT	Cathode-Ray Tube.
IHI	Ishikawajima-Harima Heavy Industries.
IMO	International Maritime Organisation.
KRISO	Korea Research Institute of Ships on Ocean.
LOOP	Louisiana Off shore Oil Port.
LORAN	LOng RAnge Navigation.
MARAD	Marine Administration.
MARIN	Maritime Institute of Netherlands.
MARSIM	International Conference on Marine Simulation.
MITAGS	Maritime Institute of Technology And Graduate Studies.
MOB	Man-Overboard.
OOW	Officer Of The Watch.
Radsim	Radar Simulator.
RAM	Random-Access-Memory.
ROT	Rate-of-Turn.
SHS	Ship Handling Simulator.
STCW	Standards of Training, Certification and Watchkeeping.
SOO/SB	Ship Operation Officer Course.
SUSAN	Shipoperation and Simulation Facility.
SWOS	Surface Warfare Officer School.
USMMA	United States Merchant Marine Academy.
VHF	Very High Frequency (Radio Communications).
VIETCOSHIP	Vietnam Coastal Shipping Company.

VITACO	Vietnam Tanker Company.
VITRANCHART	Vietnam Transport and Chartering.
VOSCO	Vietnam Ocean Shipping Company.
VLCC	Very Large Crude Carrier.
VMU	Vietnam Maritime University.
VTS	Vessel Traffic Services.

PREFACE

This paper deals with a proposal for the further improvement for shiphandling training courses at Vietnam Maritime University.

With the present sophistication of ship automation and the complication of technical management, a great number of seafarers can no longer meet the requirements that arise from the developments in technology. In September 1978, the first international conference on marine simulation (MARSIM 78) was established to study the manufacture and utilization of marine simulators including shiphandling simulators for the education, training and assessment of seamen. Since then, the urgent need of applying of marine simulators as teaching aids in an MET system has became well recognised.

Vietnam Maritime University (VMU) considers highly the importance of utilization of marine simulators in order to improve the training standards of Vietnamese seafarers. The plan for the installation of a shiphandling simulator at VMU is underway.

With the knowledge that the effectiveness of the application of the simulator could not be achieved without fully understanding it and having been a nautical lecturer of VMU and being a student of the MET course, I consider "Shiphandling Simulator - A proposed SHS training programme for Vietnam Maritime University" to be an appropriate subject for my dissertation at WMU.

By writing the dissertation, the personal understanding and important knowledge of shiphandling simulators will hopefully be gained. The shiphandling simulator training programme drawn up will contribute to the putting the application of shiphandling simulator at VMU into practice and Vietnamese instructors who are in charge of the shiphandling simulator training may acquire necessary information and knowledge about the training facility from the finished dissertation.

The auspicious conditions of gaining necessary guidance and information from good books, visiting professors and especially from the expertise in this field of my course professor is taken into account in choosing the proper topic for this dissertation.

Some difficulties are noted due to the lack of personal background in this subject, the lack of certain necessary collected materials, and the limitation of time for writing the dissertation.

In order to fully utilize the auspicious conditions and minimize the encountered difficulties in the investigation, the available materials are carefully examined and analysed. The relevant information is properly selected.

Nevertheless, with the invaluable guidance from my course professor, and co-assessing professor, the dissertation has been completed with the belief that it will provide valuable information and guidelines for the Vietnamese shiphandling simulator instructors. I feel satisfied that my efforts were worthwhile.

CHAPTER I

INTRODUCTION

'If you understand your situation, you may or may not be able to improve it. If you don't, you definitely won't.'
(Derek Rowntree)

1.1 THE VIETNAMESE MARITIME EDUCATION AND TRAINING SYSTEMS

So far, there have been two different education and training systems which have led to certificates of competency in Vietnam. They have been provided within either Maritime Technical and Training Schools or within the Vietnam Maritime University.

1.1.1 Maritime technical and training schools

The functions of these schools are :

- to train maritime technicians and ratings.
- to offer refresher courses in professional skills & foreign languages to crew members.

Two types of training are provided.

*** Ratings training**

- Sea-going vessels steering	:	24 months
- Operation of marine engines	:	24 months
- Repair of marine engines	:	24 months
- Operation of electricity network of sea-going vessels	:	24 months

*** Refresher courses for upgrading professional skills**

- Boatswains : revision & test : 3 months
- The 4th & 5th class captains & chief engineers (river-going vessels)
- Seamen 15 months course
- Motor-man 18 months course
- Ship electrician 15 months course
- Chief checkers 15 months course

1.1.2 Vietnam Maritime University (VMU)

*** Brief history**

Vietnam Maritime University was founded as the Vocational School of Navigation for self reliance and confidence in Haiphong in 1956. One year later, its name was changed to the Vietnam Nautical School. For the necessary development of a self-supporting economy in Vietnam, the government recognized that it was inevitable to rapidly advance and expand the Vietnamese waterway transportation and it decided to establish Vietnam Maritime University (VMU) in 1976. The completion of the Vietnam Maritime University development programme was reached in 1984.

*** Function and role**

- To educate and train freshmen for qualifications at bachelor level.
- To provide undergraduate and post graduate studies in the maritime field (Master of Science, Doctor of Science).
- To train and conduct examinations of new entrants to meet the international requirements for all levels of certification (3rd, 2nd, 1st officers, masters, chief engineers, chief radio operators, electrician officers,etc).

*** Departments**

VMU consists of six departments as follows :

- Navigation
- Marine Engineering
- Electrical and Radio communications
- Sea Transport Economic
- Naval Architecture
- Port construction & Hydrographic surveying.

*** Personnel**

The personnel structure or the VMU consists of :

Rector	1
Vice-rectors	5
lecturers	575
Clerical employees	200

Total	781

*** The Nautical Syllabus of VMU**

The nautical syllabus of VMU is designed to meet the international requirements for training navigating officers as laid down by the STCW (1978) convention. Details of the VMU syllabus are given in Appendix I. It consists of the following:

- The syllabus of the Navigation Department
- The syllabus of the training programme for ship master class 1 and 2.

1.2 THE CASE FOR A SHIPHANDLING SIMULATOR IN VIETNAM

1.2.1 The Vietnamese merchant fleet

In Vietnam, there are two kinds of shipping companies, namely state shipping companies and private shipping companies. The former group consists of four shipping companies:

- Vietnam Ocean Shipping Company (VOSCO)
- Vietnam Coastal Shipping Company (VIETCOSHIP)
- Vietnam Transport and Chartering (VITRANCHART)
- Vietnam Tanker Company (VITACO).

The total number of ships in the above four companies' fleets is about 90. The private shipping group consists of 10 shipping companies. Besides this, there are about 20 ships with Vietnamese crews sailing under foreign flags.

According to the list of shipowners 1990-1991, published by Lloyd's Register of shipping, the Vietnamese national fleet consisted of 142 ships with a tonnage of 401,984 GRT, including 80 general cargo ships and 11 tankers.

Before 1975 the Vietnamese merchant fleet was undeveloped due to the long war and the separation of the country. After the reunification of the country in 1975, its favorable geographical position in the region with a long coast and the development of the economy led to the increased growth of the Vietnamese merchant fleet. The average growth rate of the Vietnamese merchant fleet is recorded as 11% over the period of 1976 - 1989 (see Table 1.1 and figure 1.1).

As shown in table 1.1 and figure 1.1, the Vietnamese Merchant Fleet is increasing annually. This infers an increase in the number of masters and deck officers. Therefore, it will be necessary to provide further training for certificates of competency in order to meet the requirements for navigational safety of the present and future fleet.

TABLE 1.1 : Vietnamese national fleet, 1976 - 1989

Year	1976	1977	1978	1979	1980	1981	1982
Tonnage (GRT)	107	129	163	202	241	250	262
Growth (% Pa)	-	20.5	26.4	23.9	19.3	3.7	4.8
Year	1983	1984	1985	1986	1987	1988	1989
Tonnage (GRT)	269	279	299	339	360	381	402
Growth (% Pa)	2.7	3.7	7.2	13.4	6.2	5.6	5.5

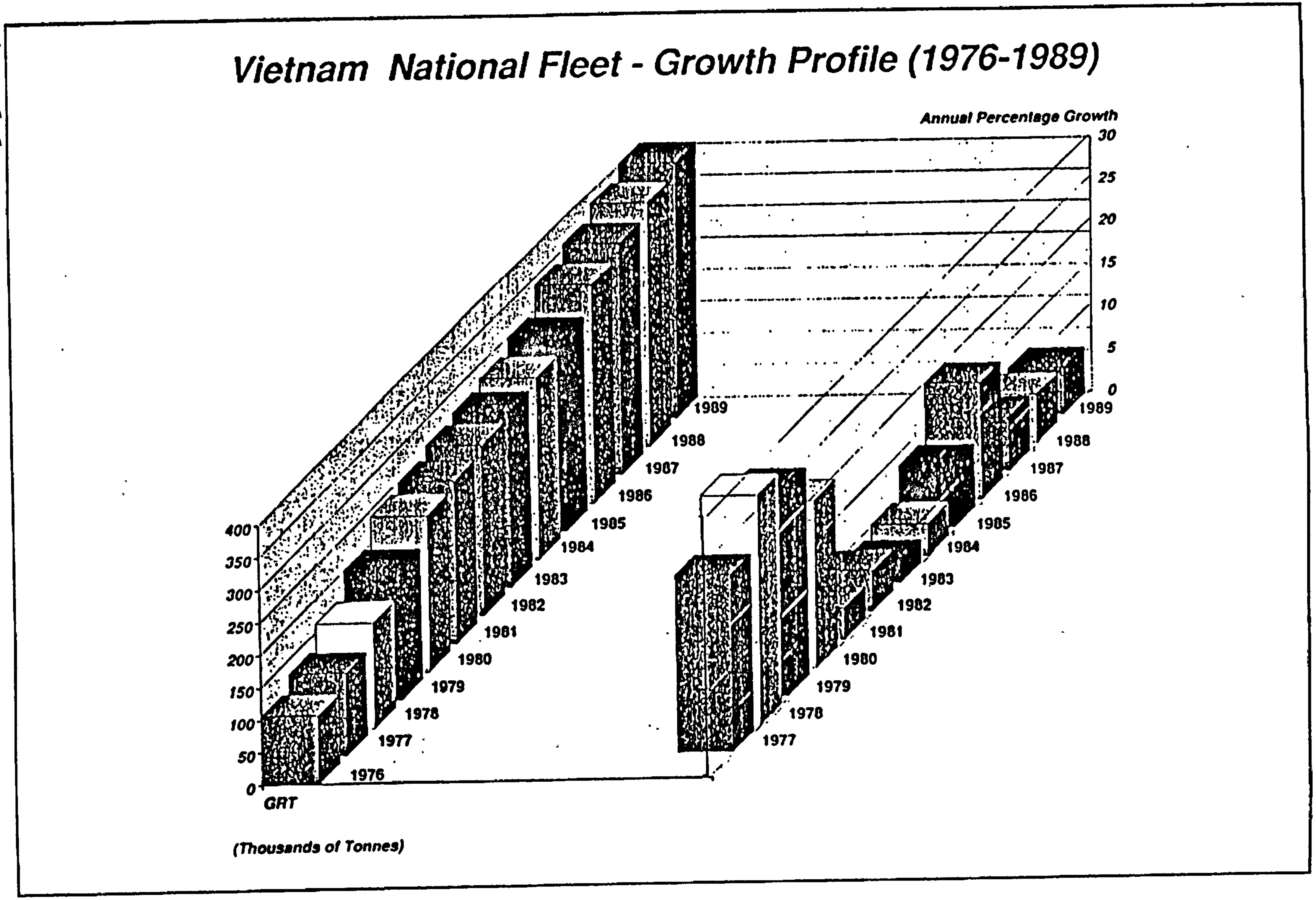
Sources : Statistical Yearbook, 1982 - United Nations
Statistical Tables 1983 - 1986 Lloyd's Register
List of Shipowners 1990 - 1991 Lloyd's Register

Note : Unit of the GRT = Thousands of Tonnes

1.2.2 A brief introduction to marine simulators

The development of means to facilitate efficient and productive waterborne commerce dates far back in antiquity together with the birth and development of domestic and international trade. The ever-increasing requirements for the transportation of goods across the ocean in ships have, today, prompted the development of advanced techniques and simulation. Several of the implications associated with the growth of waterborne commerce are :

Figur 1.1



Vietnam National Fleet - Growth Profile (1976-1989)
Annual Percentage Growth
30
25
20
15
10
5
0
400
350
300
250
200
150
100
50
0
GRT
(Thousands of Tonnes)
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989

+ port and waterway congestion and limitations
+ vessel casualties
+ loss of life, property, and investment
+ damage to the environment
+ aids-to-navigation requirements
+ training and certification requirements
+ port and harbour design operations and requirements.

With the increasing trends and pressures associated with the conditions on the open sea, harbour and on waterways, it is very important that the response to marine problem areas be compatible with, and provide the necessary training of the human resources involved in the management and operation of the ship.

Together with the development of technology, ships become more and more complex and sophisticated. With automation on board the ship replacing manpower, it requires a higher level skills of the seafarer. However, the benefits of automation and modern technology can only be achieved if the capabilities of the human are put to the best use in the relationship of human/machine/environment. It has been demonstrated that several advanced technical developments have failed because human perceptual and control capabilities have been neglected when designing each particular system. These capabilities are identified with the basic human limitations inperception, decision making and the control of machines.

To overcome the above limitation, it is necessary to incorporate in training objectives the needs, capabilities and limitations of the human operator. This has promoted the increasing trend to utilize recently developed sophisticated simulators to address the various ship subsystems dealing with navigation, piloting, engine room operations and cargo handling.

Simulators have been developed to improve training and to carry out research. The list of various types of simulators is as follows:

1. Full bridge simulator
2. Engine room simulator (propulsion)
3. Cargo handling simulator
   a. Liquid cargo simulator
   b. Liquid Natural Gas simulator
   c. Gantry Crane simulator
4. Well drilling and control simulators
5. Vessel traffic service simulator
6. Navigation Instrument simulator
7. Radar and navigation simulator.

There have also been specialized simulators built for remotely operated vehicles, crane ships and pipe laying vessels.

1.2.2.1 Part-task simulators

Part-task simulators are invaluable in providing training to a large number of mariners in manipulative skills required by many bridge operational procedures, particularly below the master/pilot level. Besides, economy in personnel and operating costs can be realized by the use of part-task simulators. The per hour cost for each trainee can be lowered by increasing the number of trainees performing any particular task while decreasing the number of instructors/operators required.

Part-task simulators consist of the following simulators:

- Loran
- Decca
- Omega
- RDF
- Ship manoeuvers
- Echo sounder
- Transit satellite
- ARPA/Radar
- Collision avoidance Regulations.

1.2.2.2 Full bridge simulator

The full bridge simulator is more complex and more costly than the part-task simulator. Therefore, it can provide many options not available from the supplementary facilities:

- Individual and team training as required;
- Integration of the skills and knowledge developed by the supplementary facilities;
- Realistic settings for true presentation of ship response under a variety of conditions;
- Full flexibility of scenarios;
- Capability for equipment degradation and/ or casualties.

The many options available in this training or research device, particularly as it may apply to transition training from smaller to larger ships, makes it more than just a viable alternative to at-sea platforms. The full bridge simulator can provide once-in-a-lifetime training opportunities that the average mariner may never experience in his many years at sea, situations which may turn into disaster without immediate corrective action. Moreover, full bridge simulators can provide unique training opportunities which would not be available to the sea-going mariner through on the job-training.

Effectiveness in this regard hangs upon the recognition of certain factors which impose constraints on at-sea training:

- operational expense
- safety
- lack of opportunity or repeatability
- availability of vessel
- operating schedules.

1.2.3 Vietnam Maritime University with marine simulators

So far, VMU is the only institution training cadets and marine masters in Vietnam. The number of marine officers is increasing with the increase in demand of seafarers for the Vietnam merchant fleet. However, up to now, VMU still lacks a number of training facilities, such as marine simulators that will enhance skill acquisition.

In recognizing the effectiveness of training using marine simulators, and in order to maintain and improve the standard of Vietnamese mariners as required by the IMO's STCW-78 convention, VMU has given much consideration to the application of marine simulators in education and training in Vietnam. A plan for installing marine simulators in VMU has been approved by the Vietnam Maritime Administration.

CHAPTER II

SHIPHANDLING SIMULATOR

'I had six serving men and true
They taught me all I knew
Their names were **What** *and* **Why** *and* **When**
And **How** *and* **Where** *and* **Who**.'
(Rudyard Kipling)

2.1 THE CONCEPT OF MARINE SHIPHANDLING SIMULATORS

The shiphandling simulator is a computerized system which can be used for various nautical training objectives :

- watchkeeping training of sea-going personnel (all levels);
- emergency response training;
- improvement of bridge organization, teamwork;
- development of shiphandling techniques;
- collision avoidance situations;
- research for port authorities and other institutes.

The shiphandling simulator evolved from the need to simulate, as closely as possible, the ship and its natural environment and the work that has to be done by the bridge team members.

Bridge work can be divided into three areas: navigation, ship manoeuvring, engine and cargo control. However, in modern marine practice, communication has a function of interconnecting these tasks. The interconnection between these tasks by communication can be shown as follows :

```
                 | - Navigation
  Communication  | - Manoeuvring
                 | - Ship, engine, cargo control
                  (this includes auxiliary engines,
                     stability, temperature, etc.)
```

Distress communication is present in all three areas. This is also true for lookout, engine control and others such as cargo temperature, fire alarm, water tight door, etc.

Table 2.1 illustrates this.(Lodhi, 1991, 12)

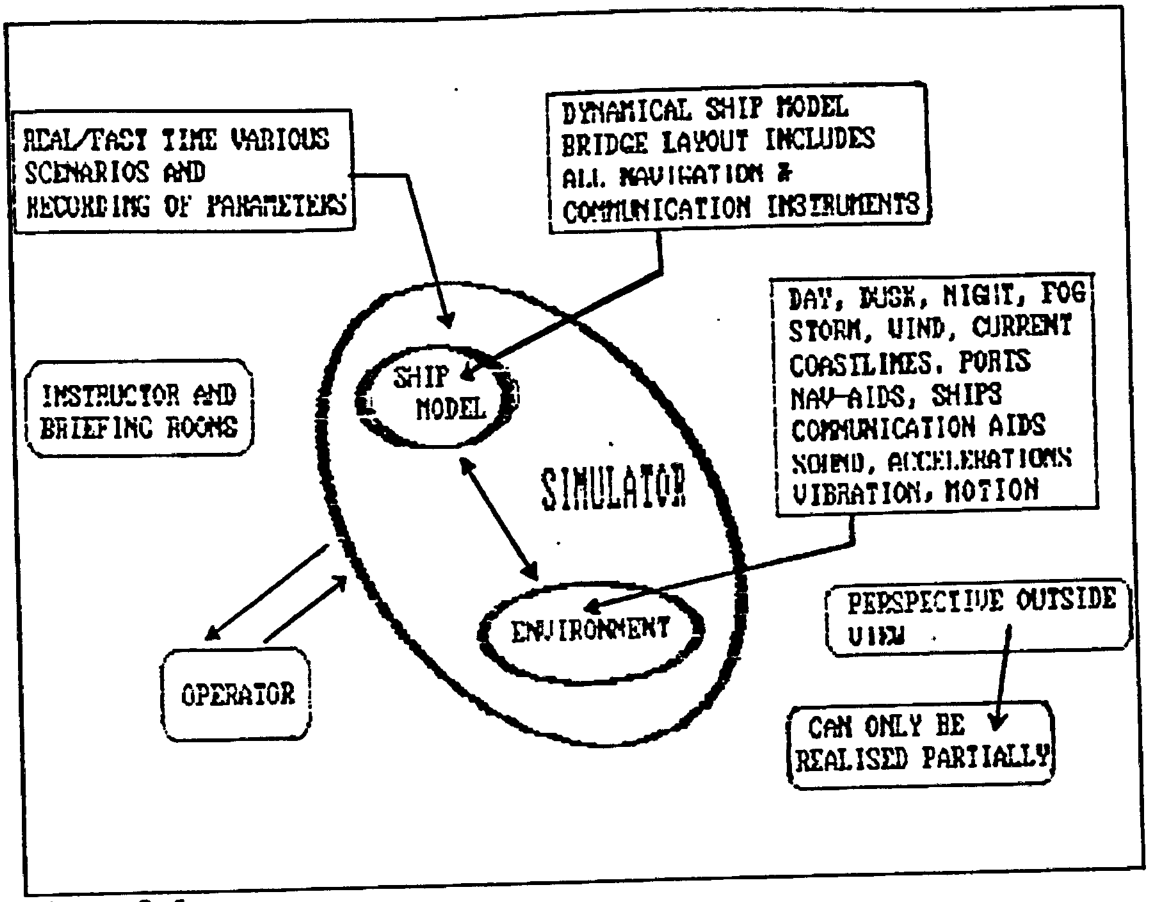
From table 2.1, the kind of training needed to practise these tasks can be seen as follows :

- track keeping and altering course;
- collision avoidance manoeuvring;
- emergency manoeuvres and procedure;
- conning of ship, monitoring of manoeuvres in narrow channels;
- berthing and unberthing manoeuvre;
- control and monitoring of main engine and auxiliaries;
- communication procedures and performance;
- adjustment, operation and use of navigation instruments;
- action in case of equipment failure.

The necessary conditions for a perfect shiphandling simulator can be seen in figure 2.1 (Lodhi, 1991, 14).

From the figure it is possible to ascertain what factors are required to replicate bridge work in a simulator. They are as follows :

(a) Reality : Viewing scene from the bridge,



Figur 2.1

Bridge layout equipment in the bridge,
Sound, such as engine noise and signals,
Light conditions and vibration.

(b) Real time training (and compressed time presentation).

(c) Various viewing scenes:
Viewing condition in clear and reduced visibility,
Day / night scene,
Presentation of various targets.

(d) Inter-connection between ship motion and systems such as engine, radar, navigational equipment etc.

(e) Easy establishment of environment conditions such as current tide, wind.

(f) Own-ship models.

(g) Setting up sudden critical situations

(h) The exchange of information between instructor and students.

(i) Record of exercises and processes of training.

Table 2.1. Classification of bridge work

Normal situation		
1. Position fix 2. Look out 3. Conning ship 4. Engine control Auxiliaries 5. Navigation plan calculation optimum 6. Cargo ---Communication-- 1. Receive weather Broadcast time 2. Public corresp.	1. Position fix 2. Look out 3. Conning ship & manoeuvre 4. Engine control Auxiliaries 5. Navigation equipment 6. Cargo -------------------- 1. Traffic control 2. Public corresp. 3. Internal	1. Position fix & watch of drift 2. Look out 3. Conning ship & manoeuvre 4. Engine control Auxiliaries 5. Nav. equipment watch 6. Cargo & mooring ------------------ 1. Harbour correspondence 2. Internal
In emergency		
	Bridge work 1. Collision avoid. 2. Stranding avoid. 3. Incidence control centre	Communication 1. Emergency communications 2. Internal

2.2 THE GROWTH AND DEVELOPMENT OF SHIP SIMULATORS

Compared with the aircraft industry, the history of the application of simulation in the maritime field is of recent origin. Today the use of ship simulators is widely recognized for both training and research.

Starting in Sweden in 1967 as a simple simulator with limited characteristics and functions, the only purpose being research work, the shiphandling simulator is nowadays recognized as a sophisticated system with multi-characteristics and functions.It is used not only for research work but also for training and as an assessment tool in an effective way.

In over 25 years of growth and development, the shiphandling simulator has seen many changes in technology. A number of techniques have been applied to develop the visual systems - a major and important component of a shiphandling simulator's system. These methods have been known as:

- the shadowgraph
- the model board
- the slide projection
- the nocturnal display
- the C.G.I visual display.

The lastest development is the laser video disk which brings with it a lot of advantages over the former techniques.

The five above methods, together with the development of ship simulation systems, can be well recognized in the research work of Muirhead (1985,30) as summarized below.

2.2.1 The Shadowgraph

A shadowgraph is an ancient means used to display a simple animated picture or scene. The Dutch simulators, such as at Delft and Wageningen, were the first to be developed and used in 1968 and 1970 respectively. These used the shadowgraph point light source system. In this method, models of the landmass, with the horizon cut out were back-projected onto the screen with the aid of a light source. When the models were moved an apparent change in the azimuth could be achieved. A slide projection was used to produce own shipbow. The shadowgraph system at Delft allowed a field of view of 120-degrees; at Wageningen up to 360 degree field of view in monochrome with day and night effects.

The same techniques were used by the Japanese for their simulators at Tokyo University of Mercantile in 1976 and at Osaka University in 1975. The limited features caused by the lack of other ships in the exercise area were overcome by superimposing a TV projection system over the basic shadowgraph.

The Dutch used their systems for the purposes of training and research. The Japanese system was used only for research purposes.

2.2.2 The Modelboard System

The modelboard system became popular in the 1970s. In this system, as described by Muirhead (1985, 32), a scaled physical model of the exercise area was constructed and a small TV camera was made to track over the surface. The monochrome picture was put on to a screen by means of a television projection system. Target ships were produced by model ships following a fixed track. The limitation was that multiship exercise situations were difficult to generate on the screen. Lack of colour for navigation lights reduced the quality of the visual presentation. It was expensive to make the play area, therefore new ones needed to be developed to expand the exercise library.

The Institute for Perception at Soesterberg was the first to be equipped with the modelboard system in 1976. This was of limited capacity. It used a simulated push-tug in day visual of a black and white scene extended over a 120 degree field of view. By this time at Delft, another modelboard system had been added to the previously installed shadowgraph. This system was able to operate own-ships up to 550,000 d.w.t with wind,current, and shallow water effects. Other target ships could be introduced to produce limited traffic situations but did not permit docking.

An extensive modelboard library of twelve port approaches was developed by the Sperry Rand Corporation for Marine Safety International and installed in their simulation facility at La Guardia airport in 1976. The system was used purely for training purposes. A three-camera probe projected a black and white picture over a 140 degree field of view forward and included a 40 degree stern view via a monitor. Five own ship types could be used by this system.

Some disadvantages of the modelboard system can be recognized. They are the initial cost of the scaled physical model, the time necessary to change from one gaming area to another and update the navigational changes on the board, and the rigid tracks that have to be followed by the other ships in the exercises.

2.2.3 The Slide Projection Systems

In the same year, 1975, the Japanese company IHI and the German company VFW-Fokker (MBB) developed and installed the Slide Projection systems. VFW-Fokker installed their system at the German Academy of Nautical Science in Bremen (now known as the Hochschule Bremen, Fachbereich Nautik). Producing its visual scene through hundreds of colour slides taken from a scale model of the play area, the picture generated was very definitive. Sea,sky and navigation aids were produced by other projectors. Simulated forces included wind, currents, shallow water, and anchoring. However, this method could not overcome the limitation of docking capability. It lacked the flexible feature with traffic ship scenarios and visibility control. IHI, in cooperation with NYK line, installed a $2m simulator in Tokyo in 1975. Four colour slide projectors were used for the landmass, and one colour film projector for the one other ship. Another modified slide-projection system for research work was also installed in Nagasaki (1975); this system provided a 160 degree horizontal field of view.

2.2.4 The Nocturnal Display

Early simulators for training mariners did not display landmass or shapes. Less emphasis was placed on the shiphandling element of training than on making a comprehensive display or navigation marks, channel buoys, range lights, etc. as seen from the bridge of a ship at night. The increasing complexity and cost of simulator design was also a reason that led to the development of a simpler and cheaper system than the existing one. Two types of nocturnal display systems have been produced: the turrets system which projects spots of light onto a circular screen from a position on top of the wheel house; and the point light source system which projects light spots on to a flat screen positioned in front of the bridge windows. The former type has been installed at the Baltimore Institute of Technology and Graduate Studies (MITAGS), the Royal Netherlands Naval College, Den Helder, and at HFN, Bremen while the later has been installed at the UK Nautical Colleges in Warsash, South Tynesside and Glasgow.

The ship simulator at the UK Nautical Colleges in Warsash was installed in 1977. This Nocturnal System produces a series of light points from up to 16 light point projectors, each controlling the intensity, colour and movement of the lights. They are projected on to a screen to give a 50 degree arc to port and starboard. The display of up to four target-ships can be available at any time. Forces produced include wind, current, shallow water, tugs and engine vibration effects. In 1981, another unit was installed, making a linking of the two possible.

The same year saw another installation of a nocturnal simulator at the Maritime Institute of Technology and Graduate

Studies (MITGAS),USA. Light points from 60 spot projectors set in a spherical housing to give a 360 degree field of view were provided by a computerized optical system. Both simulators have a fully equipped bridge including Decca, Loran C, Omega, Satnav. The advance feature is that the second simulator is mounted on a motion platform. This permits the bridge to roll 20 degrees either way and heave a maximum of 45 centimetres.

The most significant advantage of the nocturnal display is that a very high resolution night scene can, in most cases, be installed for less than one half the cost of a day light scene. It encourages the application of this system in a number of training centres.

The foregoing systems have many advantages in both design and in meeting particular training objectives. They are very useful tools for training and research. In comparison with the later technology, they are less expensive. However, some limitations can be found in these systems including lack of choice, in some cases, of the exercise area, target-ships limitations and limitations in the manoeuverability of own-ship, particularly in shallow and confined waters, CGI technology has been introduced to overcome the limitations inherent in many of the foregoing techniques.

2.2.5 The C.G.I visual display

Actually, the CGI concept is not a new one. It has been applied in the aviation field for many years. One of the first maritime visuals produced by CGI was in the Swedish State Manoeuvreing Simulator(1973). It was developed in-house, providing a 35 degree field of view through seven black and white TV screens.

The design of a CGI for an exercise is carried out in three steps. In the first step, the planner decides which objects the watchkeeper should be able to see and from which directions they can be observed (thus deciding the number of faces). Then the three dimensional co-ordinates are input into the computer memory together with the colour, texture and shading of the object. In the last step, a suite of multi-used objects such as buoys, lighthouses and fields are added. During an exercise, the computer is programmed to output to the projection or TV system the visual scene that can be observed within the field of view. The CGI presentation is likely to stay at the forefront of technology since computer power will increase and the price decrease for the same amount of memory.

In the USA considerable interest was shown in the development of ship simulation by the Marine Administration (MARAD) and the Maritime Industry. MARAD installed the first fully digitized ship simulation system in 1976. This system was known as the computer aided operations research facility (CAORF) and included full colour visuals in day or night configuration, with an ability to produce up to six traffic ships anywhere on the 240 degree screen. The simulator was built by the Sperry Corporation and managed by a number of companies including Ship Analytics Inc., and currently by Marine Safety International. It was claimed to be the most comprehensive, technically complex and expensive full bridge, full mission simulator in existence at the time. The cost was approximately 16 million US dollars, and it was used initially only for research purposes. This system was considered the father of a new era of full mission/ full bridge simulators.

In Europe, much effort has been given to improving the quality of the CGI picture. Krupp Atlas Electronic in Bremen and Norcontrol of Norway are at the forefront in research into improving CGI visuals for maritime simulation. Krupp Atlas Electronic have installed their simulators in Hamburg (SUSAN) in 1982, Two in Australia in 1985, Taiwan in 1985 and Kiel in 1987.

Though a number of methods have been introduced to overcome some existing limitations of the techniques, better solutions are still expected. For example, the main criticism of some daylight CGI presentations is their cartoon-like quality. This can be overcome to some extent by texturing the scene. This means that sharp lines and expanses of colour used to make the scene are shaded and softened. The nocturnal scene needs a high resolution display otherwise the light projected onto the screen is too great and gives a poor presentation of range.

2.2.6 The Laser Video Disk

Applying the laser video disk technique is a new method that provides many better features than the foregoing techniques.

Firstly, it is a method of handling interactive graphics. This means that the technology permits many of the best features of visual systems described above to be brought together in one visual scheme, for example still photos, modelboard images, video camera inputs. Literally any way an image can be formed for display can now be stored on a disk to be used a as data base.

Secondly, a range of unique capabilities equal and, in some cases, superior to what is available with CGI systems is given to the visual program designer by the video disk technique. Since the system can be made up using a number of disk units controlled by the simulator's computer, the scene designer is provided with great flexibility. He can easily provide for the separate control of multiple images in any given scene throughout the entire field of view. In the same way, selective enhancement can be applied putting maximum scene detail in a specific sector of the overall field of view. Finally, from an economical point of view, this system can help to reduce production costs by using the technique of a centralized multi-user computer base to produce the disk. A powerful graphics generation ability can then remain with the company that is preparing the disks.

2.2.7 The Bridge Wing Shiphandling Simulator

In 1986 the new concept of a marine simulator, Bridge Wing Simulator (BWS), came in to being. The BWS is a new application of existing technology. It is designed to overcome the existing limitations of the present shiphandling simulator. All other shiphandling simulators in the world today are so arranged that the preferred viewing point, the centre of curvature of the screen, is located on the ship's centre line and on the bridge. The place at which the ship handling trainees obtain the necessary view for manoeuvering decisions is on the ship centre-line and usually near the middle of the bridge. This is not the position the conning officer normally uses when performing the high risk manoeuvres of underway replenishment, mooring and conning alongside.

Wings have been added to many standard simulators which have the bridge centreline as the centre of the visual system . However, the research of Eugene Guest (1990, 143) shows that this has complicated the problem. The shiphandling trainee who walks out onto such a "wing" does not get the view he thinks he will get since the geometry of the theatre is for the bridge centreline observer. Guest (1990, 143) also stated that the "bridge" should be placed in the theatre so that the wing location is at the centre of the curvature. At least 75 % of all close shiphandling is done from this wing location. A shiphandling simulator must have a correct wing location which provides a correct view for the shiphandling trainee who is attempting to build shiphandling judgement.

To solve this problem, the Surface Warfare Officer School (SWOS) at Newport, Rhode Island, elected to proceed with two different simulators: One using the conventional centreline system and the other a bridge wing simulator. This BWS is unique in the world of ship simulation. An authentic bridge wing environment is surrounded by screens which provide a correct visual display and correct bearing.

The BWS has a horizontal field of view of 220 degrees. This permits the conning officer to see from 20 degrees over the opposite bow all the way around to 20 degrees over the opposite quarter. This deep vertical view allows the conning officer to see down into the dock during a clocking manoeuvre. It provides for very close approaches to objects abeam, depending upon the height of the eye of the ship being simulated.

U.S Navy officers, merchant deck officers, and harbour pilots have made use of the BWS since 1987. It has proved to be a very effective tool in training. This operational training has substantiated the assumptions made during the development phase of the new port training complex. For Navy officers, the training for making portside and starboard wings can be displayed. During an exercise the trainee can request a view from the opposite wing and, as it were, "walk" from one wing to the other. In this manner an officer-trainee can get underway from a portside mooring and make a starboard side landing, all in the same exercise run.

The BWS has the ability of shifting from port to starboard wings, the deep vertical view, and the ability to look along the length of the ship from forward to aft. These features have not previously been available in centreline simulators. Moreover, if called for in a simulator exercise, a trainee can also get a centreline view, this is a faithful and accurate portrayal of the view in front of the bridge windows, or from the flying bridge. The right visual for any shiphandling/piloting exercise, and especially for those exercises which require a special wing view, can be provided by this BWS.

2.2.8 Desk-Top Simulator

Recent developments in micro-computers make it possible to perform complicated simulation processes by using small computer systems. This development has been adopted for use in the small world of large scale ship manoeuvring simulators. Some advantages of the micro-simulator system have been recognized. The main advantages of the system is its cost effectiveness and simplicity compared to a simulator with a mock-up of the ship's bridge and a system to produce a realistic outside view. Furthermore, because of its small size it can be installed on board or at any place. The micro-simulator can be used by a ship's designer, port's designer and shiphandler.

In 1984, the Korea Research Institute of Ships on Ocean Engineering (KRISO) developed an onboard simulator by using a personal computer. The simulator was then improved in 1989. The hardware of the simulator consists of a personal computer, a colour monitor, a rudder control wheel, an engine control device, a tug control device, and a printer. The simulator was designed as a real time simulation system providing simulations of ship manoeuvring, navigation, and operation, and research tools for training under various conditions and port and vessel design.

In Japan, the research into the application of desk-top simulators was made by Akishima Laboratories and Ishikawajima-Harima Heavy Industries (IHI). Akishima Laboratories produced a handy-sized desk-top simulator for shiphandling operations and their application. With this simulator, simulations of ship manoeuvring could be carried out easily and precisely on a desk in any place. A bird's eye image on colour CRT display is used to display the ship's positions. Orders on rudder etc. are made through operation boxes, the hardware configuration of the simulator consisting of a 16-bit personal computer, a colour CRT display, a printer and two kinds of operation boxes: shiphandling box and tug operation box. The mathematical model employed is an advanced one of a modular type. This simulator has already been utilized as a useful tool for the purpose of planning shiphandling prior to the actual ship operation, port design and so on. Its typical feature is the capability of linking two desk-top simulators.

IHI, in 1973, made public its development of a manoeuvrability simulation program followed in 1975 by its realization of a mockup bridge manoeuvring simulator equipped with a visual display system. Since then, a great deal of effort in developing and applying simulator techniques for predicting and assessing a ship's manoeuvrability has been made. This has led to the development of a shipboard desk-top computer system for manoeuvring plan support, to answer the call for a readily-available means of estimating a ship's manoeuvrability. The system hardware components include one 16 bit CPU with 40 Mb hard-disk drive, a 14" colour display, numerical computation processor, 4 Mb supplementary RAM board, a digitizer, a mouse and a laser printer. Three main functions provided by the system are : manoeuvring practice using a chart, support of manoeuvring plans for passage through confined waters and retrieving requisite information from the IMO Manoeuvring Booklet.

Besides these systems, certain other desk-top simulators for maritime training and research have been developed in some other centres such as the Maritime Research Institute Netherlands (MARIN), and Hongkong Polytechnic.

2.2.9 The Future Development of the Shiphandling Simulator

Over 25 years of growth and development, the shiphandling simulator has changed from a simple model in design and with limited functions to a very sophisticated and useful tool for research and training purposes. The reluctance in accepting its the important role due to the high cost and low flexibility has gradually faded. These are well illustrated by Muirhead's statistics showing the growth of Shiphandling Simulators 1967-1993 (Appendix II). There is little doubt that there will be a continuing demand for shorebased simulator training. The reasons for this can be stated as follows :

- Firstly, the rapid development of hardware and software with the increase in computer technology power and reduction of cost;

- Secondly, the initial high cost of the shiphandling simulator can be compensated by multi exploitation of its function (training and research);

- Thirdly, the increasing sophistication of ships and continuing reduction in the manning of them means that simulators will become increasingly important not only to the training of sea-going personnel but also the evaluation and maintenance of their practical knowledge and skills for the purposes of certification under the 1978 STCW convention;

_ Fourthly, the appearance of the desk-top simulator adds more capability to shiphandling training research with a promising reduction in costs;

- Finally, the reliability of the shiphandling simulator is increasing due to the development of technology. The software enhancement's capability is a good feature of recent systems in preventing it becoming out-of-date as new technology develops.

It is relevant to state that :

> "In the future, then, it would appear that, apart from the one- off requirements for use by the military forces like the navy, maritime simulators are likely to become far more cost effective, flexible in use, and modular in design. Also, by looking at the progress going in the maritime industry, it can be seen that changes in ship operation, bridge procedures and manning will change certification requirements, and the shiphandling and other simulator can provide for efficient training methods. This is also applicable to refresher, updating and future certificate renewal courses."
>
> (Lodhi, 1991, 27)

2.3 SHIPHANDLING SIMULATOR DESIGN CONSIDERATIONS

Together with the rapid development of technologies and in order to meet the demand of shiphandling simulators for training mariners and cadets in maritime centres, institutions, and academies worldwide, a number of shiphandling simulator models have been developed. The various simulator capabilities and their performance have been designed by various producers. That causes confusion to the customers who are seeking a proper simulator for their own training purposes. In order to make a good purchase and selection for the customer, as well as proper design for the designers who seek the requirements from demand for their effective production, some main features of SHS capabilities and performance should be properly considered. Below are demonstrated some requirements for an effective shiphandling simulator and functional requirements for a maritime cadet simulator.

2.3.1 Requirements For An Effective Shiphandling Simulator

The increases in ship size, traffic density and prevalence of risk cargoes in some recent vessels' accidents are those where high traffic density and restricted waters are found together, that is where the bridge staff have to deal simultaneously with collision avoidance and navigation or pilotage, often under high stress conditions. Hansford (1978, 71) has shown two of the principal requirements for an effective ship simulator as follows:

a> It must be able to show navigation marks and other ships in the same exercise.

b> It must have high degree of realism so that a sense of stress can be created and maintained.

Besides these two main requirements, according to Hansford (1978, 71) other important requirements for a ship simulator are:

c> It should be possible to simulate a wide range of exercise areas, it should be possible to create new exercise areas easily and to change from one exercise area to another very quickly.

d> It should be possible to simulate a wide range of ship types and to change readily from one to another.

e> The ship's manoeuvring characteristics must be behaviourally correct and should have the "feel" of a real ship.

f> There should be no artificial restriction on the ship's movements.

g> The environment should be well simulated; the effects of visibility, tidal stream and wind should be provided.

h> The cost should be kept as low as possible so that the ship simulator can be widely used at nautical colleges and schools.

j> While being designed primarily for training it would be desirable if the ship simulator also had the capability for under taking research tasks of an operational nature.

2.3.2 Functional Requirements For Maritime Cadet Simulator

In order to support the effective utilization of shiphandling simulators in maritime academies, a research programme in ship simulators was published in 1982 under the sponsorship of the US Department of Transportation. It was called SIMULATORS FOR MARINER TRAINING AND LICENSING: FUNCTIONAL SPECIFICATIONS AND TRAINING PROGRAM GUIDELINES FOR A MARITIME CADET SIMULATOR. Within the publication, development of a simulator functional specification for maritime cadet training was made.

In the research, functional requirements a for maritime cadet simulator was achieved in three steps. The first step in this development process was the evaluation of the effectiveness of the various fidelity levels of the critical simulator characteristic to train each identified training objective. The second step was the identification of the relative cost ratio between each level of a critical simulator characteristic; after all, using the training effectiveness and cost information described, a recommended level for each critical simulator characteristic was identified across all the training objectives and its supporting rationate documented. The summary of the section is illustrated as follows.

*** Cadet Simulator Critical Characteristics**

The critical characteristics of a shiphandling simulator can be listed as follows :

- Visual Scene
    - . Geographic Area
    - . Horizontal Field of View
    - . Vertical Field of View
    - . Time of Day
    - . Colour visual scene
    - . Visual scene quality
- Radar Presentation
- Bridge Configuration
- Own ship Characteristics and Dynamics
- Exercise Control
- Traffic Vessel Control
- Training Assistance Technology
- Availability

*** The Analyses of The Critical Characteristics**

a> Time of Day

Three levels of this simulator characteristic listed in increasing order of sophistication are as follows : (1) night only, (2) day only, and (3) day/night.

- Estimated cost Ratio :	Night	Day	Day/Night
	1.0	2.25	2.5

- Recommended level : Night only

- Rationale :

+ Firstly, the high cost of a day/night capability over the night only capability (2.5:1) may result in pricing simulator training cadets being taken from the realm of the possible to the realm of the impossible. It appears that such increased risk is not worth the increased benefits associated with day training.

+ Secondly, due to the limited time available for the integration of simulator training into the maritime cadets already intensive schedule, it appears that prudent practice may dictate that the academies train cadets only under the more difficult nighttime conditions, even if a day/night capability were available.

+ Finally, the night only capability can provide beneficial training to senior mariners in a number of critical training categories, such as Navigation Management, Communications, and Rules of the Road.

b> Geographical Area

Three levels of this characteristic are: (1) open sea, (2) coastal, and (3) restricted waters.

. The open sea visual scene contains no land, although traffic ships and buoys may be represented as appropriate.

. The coastal visual scene contains coastal geographical areas, distance land and a limited number of traffic vessels; radar presentation and water depth data are also available.

. The restricted waters visual scene contains landmass and numerous traffic vessels close abroad in the visual scene. Complex environmental data based on utilizing water depth, wind, and current may also be employed.

- Estimated Cost Ratio :

Open sea	Coastal	Restricted water
0.3	0.6	1.0

- Recommended level : Coastal

- Rationale :

+ Firstly, almost the high priority training objectives for cadets capable of being developed utilizing the coastal geographic area capability.

+ Secondly, the more impressive, more costly restricted waters capability does not appear to be required for the identified third mate skills.

+ Thirdly, the low cost open sea capability is simply unacceptable for training the required third mate piloting skills.

And finally, the coastal capability can be effectively employed for the training of many senior mariner skills.

c> Horizontal Field of View

The horizontal field of view should be wide enough to contain the important visual cues within the training exercises for the development of the high criticality skills.

- Relative Cost Ratio :	120 deg.	180 deg.	240 deg.	360 deg.
	0.4	0.6	1.0	2.0

- Recommended : 180 degrees

- Rationale :

In order to obtain adequate horizontal separation of geographic objects for a sufficient number of training exercises to ensure proper development and generalizability of the associated visual position-fixing skills, a minimum horizontal field of view of 180 degrees is recommended. Smaller horizontal field of views can be employed such that adequate horizontal separation of geographic objects can be obtained. However, substantial danger may then exist so that the visual position-fixing skills developed may not be generalizable to other than the few unique situations observed during training. A 180 degree horizontal field of view should provide the capability for training many of the identified senior mariner training objectives.

d> Vertical Field of View

In choosing a level with this characteristic as with many of the critical simulator characteristics, the principal consideration is the specific training objectives and the necessary visual cues to train those objectives.

- Estimated Cost Ratio :	10 degrees	20 deg.	30 deg.
	0.6	1.0	1.6

- Recommended level : 20 degrees

- Rationale :

Because of the critical nature of the training objectives, which involve relative motion, collision avoidance, and shiphandling skills, a 20 degree vertical field of view is recommended. A vertical field of view of only 10 degrees is not satisfactory for several of the training objectives involving traffic vessels passing close aboard.

e> Colour Visual Scene

Two historically important colour cues in maritime operations are colours associated with aids to navigation and traffic vessel side lights.

- Estimated Cost Ratio :	Black and White	Multicolour
	1.0	1.5

- Recommended level : Multicolour

- Rationale :

Since a number of the high priority training objectives for cadets, which were judged to be completed best via simulators, involve the interaction with traffic vessels, sometimes under high cognitive workload situations, a multicolour visual scene appears to be required for the maritime cadet simulator.

f> Visual Scene Quality

The simulated visual scene should have sufficient quality such that effective training can be conducted for the desired training objectives. Factors such as resolution, luminance, contrast ratio, update rate, etc., should be effectively manipulated.

- Recommended level : No undesired visual effects adequate realism to accomplish training objectives.

g> Radar Presentation

The type of radar equipment required on a shiphandling simulator is related to the objectives of the training programme to be accomplished. Three levels of radar presentation are : (1) No Radar, (2) Low Fidelity Radar, (3) High Fidelity Radar.

. Low Fidelity Radar is a synthetic radar presentation on an appropriate CRT display with required radar or CAS functions.

. High Fidelity Radar is actual radar or collision avoidance hardware interfaced with the simulation.

- Estimated Cost Ratio :

No Radar	Low Fidelity	High Fidelity Radar
0.00	0.25	1.00

- Recommended Level : Low Fidelity Radar

- Rationale :

Analysis of the high priority cadet training objectives indicates that nearly all training objectives can be effectively trained with a low fidelity radar presentation.

h> Bridge Configuration

The physical characteristics of the simulated and the hardware are related to a certain degree to the specific training objectives to be accomplished. The three levels of pilothouse fidelity are identified as follows : (1) reduced bridge, (2) full bridge, and (3) replication bridge.

. The reduced bridge configuration is substantially smaller than an actual bridge and contains only essential equipment.

. The full bridge is a full size pilothouse and contains the majority of hardware normally found on similar vessels at sea.

. The replication bridge is an exact duplicate of the pilothouse for a specific vessel class.

- Estimated Cost Ratio :

Reduced Bridge	Full Bridge	Replication Bridge
0.7	1.0	1.7

- Recommended Level : Full Bridge

- Rationale :

+ Firstly, the replication of the pilothouse of a specific vessel is not warranted for the training of cadets since the graduates of the maritime academies may eventually serve on a multitude of vessel types. The pilothouse of a cadet simulator should be representative of a variety of standard commercial ship bridges.

+ Secondly, the reduced bridge does not appear desirable for cadet training due to (1) the lack of physical space in the pilot house for a cadet bridge team to operate, (2) the danger that irregular behavior may result from training in an abnormal pilothouse layout, and (3) the danger that the low fidelity pilothouse environment may reduce the cadet's motivation during training.

i> Own ship Characteristics and Dynamics

As with the other critical characteristics of a shiphandling/navigation simulator, the sophistication of the required manoeuvring response is related to the specific skills to be developed during the training programme. Three levels for this characteristic are : (1) deep water, (2) shallow water, and (3) special effects.

. The deep water level involves only deep water coefficients and may include constants of variable wind and current.

. The shallow water level includes the above capabilities in addition to the appropriate shallow water modifications and corresponding water depth data bases of the particular geographic area modeled. Low speed may also be available.

. The special effects level includes all the previously mentioned capabilities plus bank effects, passing ship effects, tug forces, reverse motion, kick effect, bow thrusters, and anchor forces.

- Estimated Cost Ratio :

Deep Water	Shallow Water	Special Effects
1.0	1.5	3.0

- Recommended Level : Deep Water

- Rationale :

The deep water can be employed to effectively train the majority of the training objectives. The effects of shallow water should be considered for training via other training media (e.g., classroom, small vessel) and the additional expense for the shallow water capability only be incurred if revenue-producing training involving senior mariners is envisioned.

j> Exercise Control

This simulator characteristic refers to the amount of control that the instructor has over the exercises; their selection, their modification, etc. The three levels of this capability are identified as follows : (1) exercise selection for which the instructor's control of the exercise is limited to the initial selection of the training scenario; (2) instructor preprogrammed exercise control which allows modification of a scenario at the time of selection ; (3) instructor exercise control which encompasses all the capabilities discussed above plus the capability of modifying a scenario during it conduct.

- Estimated Cost Ratio :

Exercise Selection	Instructor Preprogrammed control	Instructor Exercise Control
1.0	1.2	1.5

- Recommended Level : Instructor Exercise Control

- Rationale :

Instructor preprogrammed control would probably suffice for the majority of maritime cadet training objectives. However, since traffic vessel control is critical, the instructor exercise control level of sophistication is recommended. This capability will also assist the instructor in timing the occurrence of shipboard casualties such as loss of steering, loss of propulsion, etc. Instructor control of wind, current, and other scenario parameters, during the exercise, is not required although it is desirable for the instructor to have the capability of modifying these prior to the exercise.

k>Traffic Vessel Control

This characteristic refers to the amount of control that the instructor has over the selection, position, courses, and speeds of the traffic vessels in a given scenario. Four levels of traffic vessel control are identified : (1) canned traffic, (2) preprogrammed traffic, (3) independently manoeuvrable traffic, and (4) interactive bridges.

. Canned traffic describes the capability in which the instructor can only select traffic vessel motion from a limited number of tracks prior to the scenario.

. Preprogrammed traffic describes the capability in which the instructor can select any traffic vessel motion that he desires prior to the scenario.

. The independently manoeuvrable traffic capability provides the instructor with the opportunity to alter traffic vessel motion during the exercise in addition to the initial set-up.

. The interactive bridge capability involves the use of two (or more) simulated own ships each controlled from its own pilothouse to interact in the same gaming area.

- Estimated Cost Ratio :

Canned	Preprogrammed	Independent	Interactive
1.0	1.2	1.5	40

- Recommended Level : Independently Manoeuvrable Traffic

- Rationale :

Independently manoeuvrable traffic control appears to be required for a maritime cadet simulator because it is necessary to effectively train the proper utilization of radiotelephone (VHF) information during collision avoidance manoeuvres. The canned and preprogrammed traffic control capabilities have a serious limitation in this area.

1> Training Assistance Technology

Training assistance technology refers to the use of computer processing and display capabilities to enhance the training process by assisting the instructor and trainees to comprehensively analyze the simulator training exercises. Four types of training assistance technology are identified : (1) remote monitoring, (2) feedback displays, (3) instructor alerts/prompts and (4) training management technology.

. Remote monitoring provides the opportunity for students not participating in the exercise to observe action at another location where the instructor can provide a more comprehensive evaluation without disturbing the on-watch bridge team.

. Instructor alerts/prompts provide the instructor with beneficial visual or audio cues at critical points in the scenario in order to reduce the instructor burden during training and to give more standardized instruction.

. Training management technology involves the computer's capability to store and analyze trainee performance at critical points within the training programme in order to evaluate the training programme and individual instructors.

- Estimated Cost Ratio :

Remote Monitoring	Feedback Displays	Instructor alerts Promts	Training Management Technology
1.5	1.0	0.3	0.7

- Recommended Levels : Remote Monitoring, Feedback Displays

- Rationale : There are two reasons, as follows, for recommending a maritime cadet simulator to have a remote monitoring capability.

+ Firstly, it allows class size to be increased without causing crowding in the pilothouse. This is critical when attempting to provide a relatively large number of cadets with the benefits of simulator training.

+ Secondly, remote monitoring gets the instructor off the bridge allowing the cadets to have an appropriate sense of the responsibility for the watch. This is an important benefit of simulator training over watchstanding during at-sea training where the responsibility remains with the licensed deck officer.

m> Availability

Although many academies may have found their radar simulator to provide few availability problems, they are cautioned that this may not be the case with a shiphandling simulator due primarily to its substantially greater complexity, various minimize simulator downtime. Three general levels of shiphandling simulator availability are identified : (1) moderate availability, (2) high availability, and (3) very high availability.

- Recommended level : moderate availability

- Design goal : Operational training 30 hours per week with 95% availability; 10 hours per week maximum maintenance time

The summary of functional requirements for maritime cadet simulator is given in Appendix III.

CHAPTER III

OVERVIEW OF SIMULATION TRAINING

'A thought
Efficiency: Doing things right
Effectiveness: Doing the right things.'
(Peter Drucker)

3.1 TRAINING PHILOSOPHIES

3.1.1 The need for training philosophies

Naturally, training philosophies always proceed teaching tools. Unfortunately, this is not the case with maritime simulation. The history of maritime simulations show that training philosophies have been left behind the rapid developments in maritime training aids.

> "The gap between teaching tools and training philosophies may not have widened to the point of causing negative training, but there are some errors which are evident to both simulator operators and simulator users." (Hard and Guest, 1985, C7-2)

These mentioned errors can appear as some aspects. They can be the misjudging of the fidelity of the simulator rather than the fidelity of training. The other can be the misuse of simulators in training in order to gain the training objectives.

> "This apparent hiatus between teaching tools and training philosophies may produce disastrous results: training errors made in on-the-job training will be repeated, technology will dictate the training rather than vice-versa, and expensive simulators will be used ineffectively." (Hard and Guest, 1985, C7-1)

In order to overcome the gap between maritime simulation and training philosophies some effort has been made in researching maritime simulators and giving out the training philosophies for maritime simulator training. Below follows a brief introduction to some research in this area. While Hard and Guest (1985, C7-1) investigated the overall training philosophies of maritime simulation training, Muirhead(1985, 78) researched specifically into the training philosophy of shiphandling simulator training.

3.1.2 Training philosophy for maritime simulation training

In order to build a proper training philosophy for maritime training by simulation, Hard and Guest (1985, C7-1) have put forward four theses. In summary these state that :

- One : The distinction between emulation and simulation must be maintained.
- Two : Type of tasks should determine type of trainer required.
- Three : Specific training needs should determine how a simulator is used.
- Four : Training for decision making based on various kinds of information is more important than training for specific psychomotor reactions.

* **In the first thesis** - the distinction between emulation and simulation must be maintained - its authors make a clear distinction between **emulation** and **simulation**, by the definitions given ' To emulate is to imitate or to copy ';' To simulate is to pretend or to give a false indication or appearance'. The

meaning of **emulation** is contained in **simulation** but the meaning of **simulation** exceeds the meaning of **emulation.** Recognizing the distinction between these words, the role of each kind of simulation in maritime training should be carefully considered. For example, training equipment that is used to teach operations on such part-task simulators like RADAR, ARPA, OMEGA, LORAN C, etc., do not need to be simulators. These can be called emulators but a full bridge shiphandling simulator must be considered a simulator since it is used to teach the trainees judgement and decision-making more than to teach just procedure. From the accurate consideration of each kind of simulator, the training programs for maritime training by each kind of simulator are properly designed.

* **In the second thesis** - the type of task should determine the type of trainer required - this thesis actually states that the training requirement must preceed the piece of hardware which may be required to complete the training. It sometimes occurs that some training hardware has been built and sold before the training requirements have been well defined. In such cases the technology has dictated the training and the training has become the procedure - how to operate a given piece of equipment. This is why the emphasis here is that the training requirements must be clearly defined prior to building and using the equipment. Understanding this philosophy, the simulator trainer can avoid becoming a task-trainer who teaches the trainee the procedure instead of teaching the trainee how to make a judgement. The philosophy of training which one should be aware of, states that the important part of training is to present a clear understanding of processes controlled by that equipment.

* **In the third thesis** - specific training needs should determine how a simulator is used - its authors want to emphasize the important role of the training objectives in the simulation training process. It states that the full mission simulator may be used or misused, depending upon the training objectives. Sometimes, the instructor without clear training objectives, may

misuse the full mission simulator by giving a too simple task or too complicated exercise. This wastes time and the final goal cannot be achieved - that is judgement and decision making.

To illustrate proper training objectives the ship simulator exercises for LOOP (Louisiana Off shore Oil Port) mooring masters conducted by Marine Safety was given. The exercises were divided into two types.

1. Teaching/training exercises.
2. Paradigm decision making exercises.

Teaching/training exercises occur early in the training week. They include simulator familiarization, open sea manoeuvering to learn vessel characteristics, and initial approaches. In these exercises, the instructor and trainee operate in a seminar style, using the simulator as a tool to confirm or negate previous exercises.

Paradigm decision making exercises are another name for full mission exercises. In this work, the instructor remains in the instructor station, and the exercise becomes formal with all proper communication and procedures adhered to.

The general training objectives for mooring masters are outlined in the following statements:

1. To become more familiar with the turning and stopping characteristics of large, deep draft ships.

2. To recognize how environmental forces of wind and current affect large vessels and how these forces can be used.

3. To understand how to approach the single anchor leg mooring buoys.

4. To become familiar with LOOP operational procedures through practice.

5. To practise the judgement required to manoeuver a VLCC into and out of LOOP under both normal and abnormal

circumstances.

According to Hard and Guest (1985, C7-5), the philosophy was addressed as follows :

> "Practice time has been maximized in the training program; however, training exercises could never cover all the problems that may occur in any particular manoeuver, even if all possible problems could be identified, there would not be sufficient training time to cover everything. The training exercises have, therefore, been designed to provide patterns of problems called paradigms."

From these first three theses, it is well recognized that decision making is the most important event in handling large, slow dynamic systems.

* **In the fourth thesis** - training for making decisions based on various kinds of information is more important than training for specific psychomotor reactions - it is proved that physical habit patterns in the simulator do not necessarily demonstrate the psychology of the trainee, i.e. training designed to alter physical habit patterns will fall short of the mark. This is true for two reasons. Firstly, the mariner controls the ship or shipboard systems with his mind, not with a properly trained muscle response. Secondly, the physical manipulation of controls to carry out the decision are often made by someone other than the ship's officer. In reality he is more a manager or supervisor of this operation. Once more, Hard and Guest (1985,C7-6) make an emphasis on decision making:

> "A simulator training program for mariners must teach thinking and associated decision making more than it does tasks and how to perform them."

3.1.3 Training philosophies for SHS training

The training philosophies for SHS training are fully and clearly stated by the research of Muirhead (1985,78). In the research, it can be recognized that, to some extent, Muirhead has the same point of view about the training philosophies for maritime simulations as Hard and Guest in their four theses. For example, having the same idea with thesis two, Muirhead(1985,79) writes '... and reinforces the need to establish the training needs first before designing and acquiring the simulator.'; the main point of the first thesis can be recognized in the research:

> "This does not necessarily imply that the simulation must be an exact copy of the real world,...
> It serves no purpose to duplicate experiences that the seafarer can gain in the " at sea " situation in an identical time frame. Training should be used to improve the level of proficiency in those tasks or aspects in which sea experience proves to be inefficient or deficient."
>
> (Muirhead, 1985, 80)

The important role of the training objective in the simulation training process stated in the third thesis is also included in the research of Muirhead when he wrote that a training program must focus on specific skills; The structure should be designed to meet the desired training objectives, result in optimum performance, and the task objectives should be clearly laid out. Since this would prevent the introduction of any extraneous variables by the instructor, that might influence the task or performance beyond that conceived by the original training objective.

Making specific research into training philosophies of SHS training, Muirhead argued that the shiphandling simulator is a complex and expensive training medium. It is inefficient and costly as a means of training mariners in simple basic skills. Students should have a fundamental grasp of the collision avoidance rules, watchkeeping procedures, the operation and use of radar and other navigational aids, and of basic ship manoeuvering principles, etc., before proceeding to skill enhancement training on the simulator. This is achieved by part-task training and has been conducted successfully in some areas (for example with radar observer and radar ARPA courses). In other areas such as shiphandling, little practical pre-simulation training has been carried out. The development and use of a microsimulation system providing a plan view of a ship and exercise area for basic shiphandling training can lead to the acquisition of some practical understanding of ship manoeuveres. The integration of part-task training into a full-task training program later can be achieved with considerable success. From practice, experience shows that effective training time is lost on a simulator if the student has not undergone part-task training in critical core objectives beforehand. By integrating these part-task training and acquired skills into the simulator program, proficiency in watchkeeping skills is raised in a much shorter time.

When making a plan for the use of the shiphandling simulator for shiphandling training, an important principle to be followed is to maximize the involvement of students in this area of skill acquisition. With large groups of students this becomes a difficult proposition, and a compromise must be made in the range of seamanship skills that can be included in any program. Even when short course modules are planned, where the experience levels of participants are much greater, the principle remains the same: the range of two to four exercise participants being recommended, depending on the program.

The importance of pre-briefing lectures, training materials, feedback information from the instructor and post-exercise de-briefing, must not be overlooked. The important role of the instructor must also be taken into account. A number of experiments prove that the instructor has a greater impact on the effectiveness of deck officer simulator-based training than any of the specific simulator characteristics investigated. Therefore, the training device should directly address and assist the instructor in conducting training.

In summary, training by simulation involves developing skills to perform specific tasks to meet designed training objectives. It involves the use of both mental and physical response by the mariner to a visual information input. In order to make effective use of SHS in training, due to time and student number constraints, a number of matters must be considered:

- The trainer must look carefully at the training demands by examining the tasks necessary to meet the objectives as dictated by such restraints.
- The training programme should be designed to improve the level of proficiency, encouraging the use of judgement and decision-making processes. The program should make full use of pre-briefing lectures, teaching materials, instructor feedback and post-exercise debriefing in the overall plan.
- The influence of input from the instructor on the success or failure of the training program must be taken into account.
- The use of part-task training to prepare mariners prior to commencing training on the shiphandling simulator should be considered where possible.

Limitations in the training objectives that can be achieved are present; the role of the instructor is to ensure the optimum return for safe, effective ship operations.

3.2 SHIPHANDLING SIMULATOR TRAINING PROGRAMMES IN SELECTED COUNTRIES/CENTRES

3.2.1 Watchkeeper level

3.2.1.1 Merchant Marine Academy, Kings Point, USA

The US Merchant Marine Academy at Kings Point, New York makes use of its training facilities for simulator training of the graduate cadets. The programme is called Bridge Watchstanding Simulation Training For Cadets. It is designed to enhance the potential Third Mate's decision making skills as it applies to traffic and voyage planning situations and to sharpen the cadet's bridge watchstanding skill to the highest level prior to graduation. The objectives of the training programme which cover basic shiphandling, rules of the road and bridge procedures/tasks are described as follows :

1. Understand the manoeuvring capability of own-ship :
   - Amounts of rudder required for various manoeuvres, rudder orders, rudder response time.
   - Heading change rate and its time dependency.
   - Engine speeds and vessel manoeuvring, engine orders, engine response time and limitations.
   - Speed change and its time requirements.
   - Effects of environment on shiphandling.

2. Understand the importance of monitoring and assessing traffic situations and to identify collision risks :
   - Real world application of the International Rules of the Road.
   - VHF communication.
   - Maintaining an efficient lookout and taking visual bearings.
   - Information to Master using relative bearings and drift.
   - Timely alterations of course.
   - Special circumstances and ambiguous Rules of the Road situations.
   - Manoeuvring the vessel in extremis.

3. Keep a safe navigation watch in coastal waters and while approaching a pilot station :

- Reading and following Standing and Night Order.
- Monitoring all bridge equipment and to respond to the information or to a malfunction.
- Watch Transfer.
- Communication.
- Preparation of a ship for port arrival.
- Log book entries.
- Preparation of a passage plan and monitoring progress of vessel in accordance with the plan.

Below are the main features of the training programmes : Each section is divided into Bridge Watch Team of 3 or 4 Cadets each. Watch teams are scheduled as in table 3.1.

Table 3.1

Every	Teams	Time
Tuesday	A1 and A2	0700 - 1000
Wednesday	A3 and A4	0700 - 1000
Thursday	B1 and B2	0700 - 1000
Friday	B3 and B4	0700 - 1000

Each watch team has 2 hours on the simulator and 1 class hour per week. After each hour on the simulator, the watch team is thoroughly debriefed for an hour. Before the scheduled time on the simulator, each watch team prepares, for at least an hour, for the scheduled event.

Every Friday from 1310 - 1400, all the teams will have a classroom session for debriefing and preparation for the next week's scenario.

A detailed training programme is illustrated in table 3.2.

With the training programme, practical application of Rule of the Road and development of correct bridge procedures will be emphasised. Open sea and harbour conditions will be simulated for day as well as night using the simulator.

Table 3.2 VOYAGE NEW YORK TO PORT INTERNATIONAL SCENARIOS

Time(*)	Scenarios
1/2 hour	Bridge and Vessel familiarization.
3/4 hour	Vessel at Stapleton - Prepare for Sea,Master on bridge, weigh anchor; Full away - Master departs bridge (day).
1 hour	Prepare for arrival and arrive New York (night) Sandy Hook pilot boards, Master in cabin, Pilot/Watch Officer relationship and transfer of watch in pilotage waters.
2 hours	At-Sea Rules of the Road scenarios; various steering failures and reduced visibility (day & night).
1 hour	Prepare for arrival & arrive Cristobal anchorage (sunrise); begin grading watch teams.
1 hour	Prepare for departure Cristobal (day); depart from.
1 hour	Transit Singapore Straits and transfer of watch (night).
1 hour	California Coast watch in vessel traffic lane and transfer of watch (day).
1 hour	Arrival preparation and arrival Santa Cruz Channel for Port International (day).
1 hour	Depart Port International under Santa Cruz VTS in a mine swept channel for sea (night).

(*) Note : Time on Simulator For Each Watch Team.

3.2.1.2 Hamburg Fachhochschule

The duration of one full-time degree course for the first watchkeeping certificate, the Wachoffier auf Grosser Fahrt (AGW) or deck officer (Foreign-Going) - unlimited trade in Germany Maritime Academies is 3 years. On successfully finishing the course after 24 months of sea service, the graduate is issued the Master Certificate (AG) without taking any examination. Before entering the Maritime Academy, most of the students have served for some years on board ship as Ship Mechanic or Able-Bodied Seaman in order to obtain their qualifying sea service.

In the Hamburg Fachhochschule, the simulator training programmes for AGW students have been carried out in the final semester. As the AGW students can be classified into two groups namely students with sea-going experience and students without sea-going experience, so the simulator training programmes have been designed for each group respectively.

For both the two groups, the overall objective of the simulator training programme is that, the participants, after finishing the training programme, shall be able to :

- understand and learn which information is needed for the decision finding process.
- select and evaluate relevant information, then decide and communicate within the man-ship-environment system.
- carry out responsibility all watch officers routine tasks.

For each group, the objectives and contents of the training programme has been designed in more detail as follows :

a> Cadets with sea-going experience (students)

*** Objectives :**

After finishing the training programme, the participants must be able to :

- stand a bridge watch under normal conditions. These conditions also include system disturbances.
- define situations and developments when competent assistance (Master) is needed, and establish the need for this assistance by early and proper information.

*** Duration and contents :**

With the duration of 9 weeks (3 hours per week), the tasks covered under the training programme include :

. Bridge/equipment familiarization
. Manoeuvring behaviour of vessels to be used
. Assessment methods and tools
. Preparation of watch
. Taking over of watch
. Handing over the watch
. Proper and effective information.
. Internal and external communication.

b> Cadets without sea-going experience (students)

*** Objectives :**

After finishing the training programme, the participants must be able to :

- understand and evaluate a complex shiphandling situation in order to define proper actions.
- define the governing parameters influencing the man-ship-environment system.

*** Duration and contents :**

Duration of the training programme is the same as the one for the training programme of cadets with sea-going experience, following a two week seminar (8 hours per day).

The contents also cover all tasks for cadets with sea-going experience, plus operating bridge equipment, practical helmsman operations, practical lookout operations and giving assistance to an officer of the watch.

A typical training programme for last semester students is illustrated in appendix IV. The programme is called Ship Operation Officer Course (SOO/SB). In the first 4 sessions of the initial familiarization phase and additionally the 1.5 hours of introduction to one-man bridge watchkeeping, a full group of 6 students is present on the bridge. In the following 9 sessions, the group is reduced in size to three students. Each session is 3 hours in length. This means that, during the simulator course, each student receives approximately 41 hours of watchkeeping and shiphandling experience; although individual watch control is only about 9-12 hours.

3.2.1.3 Australian Maritime College, Tasmania

The watchkeeper level training programme at the Australian Maritime College (AMC) is spread over a sandwich type course of 4 years diploma divided into 8 semesters of which 5 semesters are in the college and 3 semesters at sea. The objectives of the programme are to provide mariners with practical skills in a progressive way as knowledge and experience is acquired. The diploma also covers the syllabus content for a master mariner certificate. Thus, some aspects of the skills at this level have been included. However, unlike Hamburg, mariners in Australia who seek to obtain a Master Mariner Certificate on completion of the required sea-service will have to attend a short course practical module, utilizing simulators and other equipment. An update on new techniques and equipment is provided in the programme.

The use of the shiphandling simulator provides practical experience in those seamanship and navigational skills in which the student is expected to demonstrate an understanding and competence for both a watchkeeping certificate and the award of a Diploma. The training objectives of the simulator training programme are to provide students with a broad understanding of the principles of safe navigation, collision avoidance rules, watchkeeping procedures, shiphandling and reacting to simple emergency situations.

The integration between the shiphandling simulator programme and the existing radar simulator and navigation programmes running concurrently through years 2, 3, and 4 is carefully considered. Part-task training is an important part of the programme structure. The exercises are designed to practise the following main tasks :

a> Maintain a bridge watch at sea in all conditions and the safe navigation in busy traffic situation.
b> Con the ship safely with the use of recognized helm orders.
c> Approach an anchorage and bring a ship to a single anchor.
d> Enter and make a passage in a buoyed channel.
e> Use the communication systems on the bridge in the correct way.
f> Turn a single-screw vessel short-round, and a twin-screw vessel in a channel.
g> Berth or unberth a vessel (single- or twin-screw) without tug assistance, with or without bow thruster.
i> Respond to simple emergency situations.

The main features of the simulator training programme at AMC can be summarized as follows :

The deck watchkeeper training requirements at the AMC are subsumed within two schemes. They are the Diploma of Applied Science (Nautical Science) and the Diploma of Applied Science (Shipmaster).

The Diploma in Applied Science (Nautical Science) is intended to provide Australian sponsored trainee deck officers with the academic knowledge and practical training necessary to progress from junior navigating officer to shipmaster. It covers all fundamental knowledge requirements for certificates of competency as second mate (watchkeeper) and master (unlimited).

The Diploma of Applied Science (Shipmaster) is intended for other serving mariners wishing to obtain a certificate of competency as watchkeeper, chief mate or shipmaster within a recognised educational award.

For both schemes, two stages of watchkeeping simulator training will be applied as below :

* **Stage 1 :**

Students undertaking the watchkeeper study programme are assessed in the following subjects : Radar/ARPA, Electronic Navigation Aids, Coastal Navigation and Navigation Safety; making use of both the radar and ship simulators.

The duration of the simulator training programme covers 15 weeks. During the first ten weeks of the semester, students attend subject lectures and tutorials, including 18 hours using the radar navigation simulator for Radar/ARPA and electronic navigation aids training. Over the next five weeks, both simulators are used throughout one day each week to assess student skills. The details are given in table 3.3.

Table 3.3 - Simulator Programme

Simulator	Module	Time per Student	Topic
Radar Navigation Simulator	1 2 3	1.7h 1.7h 1.7h	Radar, RDF, CoastNav Omega, LoranC, Decca Arpa, GPS, Coast1Nav
Shiphandling Simulator	4	3h	CoastNav/Nav safety

*** Stage 2 :**

At this stage, students are undertaking studies in preparation for a chief mate or master (unlimited) grade of certificate. Two units of **command navigation 1** and **command navigation 2** are provided.

The objectives of the **command navigation 1** is to provide students with thorough understanding of navigational theory as it applies to planning, operations and safe conduct of passages in ocean, coastal and pilotage waters. Students are also expected to be able to identify and understand the use of all sources of information pertaining to safe navigation.

The purpose of the **command navigation 2** is to put the fundamental knowledge into practice through the applied use of the simulators. To develop decision making skills and to define problems and hazards in navigation for ensuring the safety of the ship in all circumstances are two main objectives of the programme. The topics of the three simulator exercises used in this stage are given in table 3.4.

Table 3.4

Exercise	Topic	Simulator
1	Passage planning	Shipsim
2	Collision avoidance	Radsim
3	Passage planning	Shipsim

3.2.2 Master Mariner Level

3.2.2.1 Hamburg Fachhochschule

To make an effective utilization of the training facilities, a number of shiphandling simulator courses have been developed at Hamburg Fachhochschule. The shiphandling simulator course for master mariners at Hamburg has been designed in order to optimize the participants' capability in ship operations following defined safety and economy requirements by confrontation with realistic situations and developments.

The experienced masters, well familiar with all routine tasks, will, having finished the training course, be expected to develop a strategy to avoid so-called competent errors, involve their officers in the decision finding process and be able to cope with emergency situations within a risk management programme. Two types of vessels of interest are container vessels and tankers (VLCC). The duration and contents of the simulator training programmes for each type of vessel are given as follows.

*** Container Vessels (or similar)**

The duration of the course is 3 days (8 hours each). The contents of the training programme cover :

. Bridge/equipment familiarization

- Manoeuvring behaviour of vessels to be used
- Assessment methods and tools
- Anchor manoeuvres under difficult conditions
- Boarding pilot under difficult conditions
- Berthing and unberthing with and without tugs
- Master-pilot relationship
- Giving assistance to a hampered vessel
- Risk management : black out
  emergency stop
  man overboard
  search and rescues

*** Tankers (VLCC) or Large Bulk Carriers**

The duration of the course is 5 days (8 hours each). The contents of the training programme are given as follows :

- Bridge/equipment familiarization
- Manoeuvring behaviour of vessels to be used
- Assessment methods and tools
- Anchor manoeuvres under difficult conditions
- Clearing sharp bend (shallow water)
- SPM mooring
- Lightering manoeuvres, stationary and underway
- Berthing and unberthing with tug assistance
- Giving assistance to a hampered vessel
- Master-pilot relationship
- Risk management: black out
  emergency stop
  break down of steering gear
  man overboard
  search and rescue

3.2.2.2 Australian Maritime College, Tasmania

At AMC, besides the internal simulator training programmes for the two training schemes: the Diploma of Applied Scienced

(Nautical Science) and the Diploma of Applied Scienced (Shipmaster), a number of external simulator training courses have been designed in order to make full use of the available simulator training facilities at the college and to meet the domestic and international demands of the training on marine simulators from the shipping industries. The shiphandling course illustrated below is one of the external courses at AMC. It is the Shipmaster's Shiphandling Course and was arranged for BHP Transport Ltd. With a duration of 4 days, the course was designed in order to examine shiphandling theory and current practice and to provide practical experience under simulated conditions of the handling characteristics of various types and sizes of vessels. Particular attention was paid to the shiphandling problems which most commonly confronted the ship's master. Additionally, use was made of AMC's Diesel Engine Simulator to demonstrate engine characteristics and the effects of controls.

Exercises varied in degree of difficulty from simple basic manoeuvres up to handling in marginal environmental conditions and/or conditions of navigational constraint. In order to achieve the maximum benefit from the limited time available, the aim was to move quickly from simple trials to more complex and testing manoeuvres. At the completion of the course, all participants would be expected to be familiar with the basic theory if not the practice of shiphandling.

During the first three days, in the mornings, the course began with lectures. Exercises on the ship simulator were carried out after each lecture. Debriefing was given at the end of the course on the fourth day. The lecture on Engine characteristics and bridge controls then practicing on Diesel Engine Simulator was also included in the first day's schedule.

The topics to be covered by the ship simulator exercise programme were given as follows :

1. Reducing speed
   - methods of slowing from full sea speed
   - comparisons of large and small vessels
   - power/weight ratios.
2. Turning
   - shallow water effect
   - effect of engines on turning circles
   - judgement of turns (use of ROT meter)
3. Anchoring
   - coming to a single anchor
   - wind and tide effects
   - traffic problems
4. Approaching a pilot station
   - coping with traffic
   - making a lee
5. Channel navigation
   - passage planning and execution
6. Berthing
   - Into tide, wind on and off the berth
   - limiting factors to berthing without tugs
   - use of anchors
7. Unberthing
   - use of springs
   - use of anchors
8. Emergencies
   - turning short round in a channel
   - turning on anchor.

Within the Diesel Engine Simulator programme, the topics covered were:

1. Characteristics of diesel and turbine engines
2. Effects of manoeuvres
3. Bridge controls - overrides.

3.2.3 For Pilots and Other Seafarers

3.2.3.1 Hamburg Fachhochschule

In Hamburg, the shiphandling simulator courses have been carefully designed for pilots. Though the duration is the same 5 days (8 hours per day) for both Pilot-apprentices and Pilots,experienced; the objectives and contents of the training courses for the two are different based on the experiences of each level.

For Pilot-apprentices, the training objectives have been designed so that the participants should become familiar with the particulars of their future area of service. They must be able to perform all the 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.

In order to achieve the training objectives, the training programme contains the following topics :

- Assessment methods and tools
- Handling of various vessels
- Operating all common bridge equipment
- Conning through the entire service area with various vessels under define a traffic, weather, time and visibility conditions.
- Master-pilot relationship
- Internal and external communication
- Dealing with emergency situations

For the experienced pilot, the training objectives have been designed so that the pilots should be able to cope with emergency situations within a risk management programme. As such they need to be familiar with all actions to be taken after an accident to minimize damage. Within the training programme, situations and conditions which led to casualties shall be reproduced, investigated and evaluated in order to derive strategies to avoid future accidents.

The contents of the training programme are broad. The topics to be covered are given as follows :

- information of master before boarding the vessel
- initial information to master after boarding
- collecting information
- approaching berth
- berthing
- unberthing.

Besides the shiphandling simulator courses for cadets, masters and pilots as previously mentioned, shiphandling simulator courses have also been designed for other objectives such as Shiphandling Simulator Courses for VTS-operators (apprentices and experienced) and for Shiphandling Simulator Instructors (with and without simulator experience).

3.2.3.2 Australian Maritime College, Tasmania

At AMC, external courses for pilots have been developed through a series of modules designed based on their experience levels and the needs of the work place. THE CONTROL OF LARGE VESSELS UNDER PILOTAGE: PORT OF NEWCASTLE was one of these courses. This course was designed for serving pilots, and provided an opportunity for them to observe and experience the behaviour of large vessels in their own port under variable conditions of loading and environment. In addition, the exercises allowed the pilot to increase his level of experience of ship behaviour in unusual wind and current forces in his port, by testing out new manoeuvring and berthing techniques in response. Though, the course referred to Newcastle in particular, it can serve as a model for any port. The illustration of the course below provides an understanding of the shiphandling simulator courses at AMC.

The course length was 5 days, the number of participants was limited to 2 pilots. During the course, the use of a 240,000 tonnes (half loaded) VLCC and a 147,000 tonnes dead weight bulk carrier was made. Particular attention had been focused on movements in and out of the port and in the use of tugs to assist in manoeuvres. An insight into the handling characteristics of a bulk carrier at different speeds in deep and shallow water was provided at initial modules. The exercises also permitted the pilot to see the problems facing the shipmaster when the latter was approaching from seaward in difficult conditions to pick up pilot, or when departing the port.

The training objectives of the training programme were designed as follows :

1. To extend the range of experiences of serving pilots in the handling and control of very large vessels in their own ports.
2. To provide a greater understanding of the effect of environmental forces upon the behaviour of large ships, through the experience of reacting to them.
3. To provide experience of shallow water and interaction effects of large vessels.
4. To investigate docking procedures with tugs when under the influence of extreme wind and/or current conditions.
5. To promote an increased awareness of the value of manoeuvring data and radar Parallel Index techniques in controlling the vessel in channels in extreme conditions.

All the exercises were executed through ten modules. Though the choice in own-ship model had deliberately been restricted to the use of two large ships, pilots were free to use any of the models as they wished. The programme was run with two pilots, alternating between duties as pilot and helm. No other staff were on the bridge, unless requested. No specific emergency situation scenarios had been included in the programme outline. It was proposed that such situations be included in the exercises by the instructor following discussions with the pilots.

The details of the course are given in appendix V.

In conclusion, a brief look at the SHS training programmes in selected maritime centres and countries gives the impression of the effectiveness in utilizing the full capabilities of shiphandling simulators. The training programmes have been designed for all mariners'levels. The well structured and clearly aimed programmes reveal the extensive capabilities in training mariners at these maritime academies.

However, one drawback is the constraint of time and number of participants on the ship simulators. The limitation can, to some extent, be overcome by the effective and sufficient utilization of the capabilities of the training facilities. This can only be achieved by well and deliberately structured programmes taking into account the constraint of time, number of participants and all the functions of the available ship simulators.

CHAPTER IV

ADVANTAGES AND DISADVANTAGES OF THE SHIPHANDLING SIMULATOR

'Hear and forget; see and remember; do and understand'
(A Chinese proverb)

4.1 ADVANTAGES

The SHS has many advantages over a conventional training ship. The major advantages of training on SHS can be listed as follows:

4.1.1 From an economical point of view

Sophisticated simulators are very expensive. However, together with the rapid development of computer technology, simulators have become cheaper and cheaper. In comparison with training on a conventional ship, SHS's operating costs are relatively low since there is no cost for fuel, less manpower, and a lower investment cost.

4.1.2 From the training point of view

There are a number of advantages for training on an SHS compared with a conventional ship. These can be listed as follows:

a> It is continuously available for training independent of weather conditions.

b> It is possible to train for extreme situations. Dangerous exercises can be practised; particularly emergency situations.

c> Exercises can be frozen on the screen and mistakes can be discussed immediately. The record of the exercises'process is very worthy in making adjustments and analyzing the performance of the trainees.

d> Exercises can be repeated in similar or different environments. The repeatable feature allows performance of different teams under identical inputs to be compared. This opens up the possibility to assess the candidates in bridge teams on the simulator.

e> Preselection of conflict situations is available.

f> Considerable time can be saved on training on an SHS.

g> Trainees can easily become familiar with different ports, harbours and the handling of different types of vessels. This is a very significant advantage of the SHS over conventional ships when the training is applied in maritime situations.

h> Being shore-based, it can accept a rapid turn round of trainees.

i> It has a high educational value; malfunctions in shipborn equipment can be simulated in a safe environment.

J> Future shiphandling techniques, procedures and rules (pilotage) may be developed.

4.1.3 From the researcher's point of view

a> The use of a shiphandling simulator may support a maritime court case.

b> Possible investigation of navigational problems may be made at a minimal cost.

c> It is a good tool to assess the safety in congested waterways.

d> It may be used for planning waterways or harbours (port development and design).

e> It may be used in designing new types of ships.

4.2 DISADVANTAGES

There are some disadvantages of the SHS:

a> High investment of capital and running costs, training of specialist operators, instruments.

b> It quickly becomes out-of-date due to newer technological developments in the industry.

c> There is a limit imposed by the time and the student number factor on the number of tasks that can be practised on the simulator.

d> Certain features may be unrealiable (ship models, wind and tidal forces, etc.).

e> There has been a lack of reality and a limitation in the current technology (visual system, bridge equipment, etc.).

However, the current disadvantages of the shiphandling simulator are nowadays being overcome with the developments of new technology and training techniques. For example, the high investment in capital, the running costs and training can be regained by expanding the exploitation of the simulator; the problem of quickly becoming an out-of-date of model can be overcome by adding an enhancement capability to the simulator system; the limitation of time and student number practising on the simulator, lack of reality and the operational limitations of the system can be minimized by applying proper training programs designed with specific training philosophies in mind.

CHAPTER V

A PROPOSED SHIPHANDLING SIMULATOR TRAINING PROGRAMME FOR VIETNAM MARITIME UNIVERSITY

'You do the thing right because you have experiences;
You have experiences because you did something wrong.'
(Unknown)

5.1 DEVELOPMENT OF TRAINING PROGRAMMES

At Vietnam Maritime University (VMU), there are two schemes of nautical training that lead to the need of training on a shiphandling simulator. These are the Bachelor in Nautical Science and the Upgrading Training Programme for Masters. The training syllabi of these two schemes are given in appendix I. As mentioned in Chapter I, the need of simulator training facilities at VMU has been recognized by the University and the Vietnam Maritime Administration. A plan for installing marine simulators at VMU will be carried out by the end of 1993. The general description of the proposed shiphandling simulator for VMU is given in appendix VI.

With the current syllabus of nautical training programmes at VMU, the proposed SHS training programmes below will be designed to meet the objectives of making full effective use of the facility taking into account the adaptability of the training programme on SHS with the current nautical training programmes at VMU. Thus the proposed SHS training programmes will consist of two types of training :

(1) Watchkeeper training programme for Bachelor in Nautical Science students.
(2) The SHS training programme for senior officers participating in the Upgrading Training Programme for Master at VMU.

Accordingly, the development of programmes relating to the use of the shiphandling simulator must be examined as follows.

5.1.1 Bachelor in Nautical Science

Students of the Bachelor of Nautical Science Scheme follow a course which prepares them for a third mate certificate and takes them up to the master class 1 certificate level. The training programme for these students is a comprehensive one covering ship operations, navigational safety and navigation throughout the five years of the course. The entry level for the students is the completion of high school studies. During the five-year course, the students have to attend 119 weeks of lectures spread over 9 terms in the first four years. Added to the programme is 42 weeks of practice at sea spread over five years. At VMU, students have 8 weeks each year for holidays, so the time for students at school and at sea is 40 weeks per year. The course structure is illustrated in table 5.1.

Table 5.1

Week	Year 1	Year 2	Year 3	Year 4	Year 5
1	Military				
2	practice				
3					
4		Term 3	Term 5	Term 7	
5					
6		(14 w.)	(14 w.)	(12 w.)	
7					At sea
8	Term 1				
9					(24 w.)
10	(14 w.)				
11					
12					
13				Exam 1.5	
14					
15		Exam 2w	Exam 2w		
16					
17					
18	Exam 2w				
19				Term 8	
20					
21				(12 w.)	
22		Term 4	Term 6		
23					
24	Term 2	(14 w.)	(14 w.)		
25					
26	(14 w.)			Exam 1.5	
27					
28					Thesis
29					& Final
30					Exam
31			Exam 2w	Term 9	(16 w.)
32		Exam 2w			
33				(11 w.)	
34					
35	Exam 2w				
36		At sea	At sea		
37		(6 w.)			
38			(8 w.)		
39	At sea				
40	(3 w.)				

As seen from the course structure, during the first four years at school the students will attend 9 terms of lectures. The structure of the Bachelor lends itself to the introduction of a simulation programme in the shiphandling and navigational safety field on a progressive scale through the first four years of the course . To make full use of the available ship simulator, taking into account the experience and profession of the student through his course, leads to the introduction of the following programme outline :

YEAR 1 (Terms 1 & 2) :

During the first year, all the subjects provided for students are for basic general scientific knowledge. No nautical subjects are given except the subject "Fundamentals of Seamanship". Therefore, no hours of SHS training programme are required in this year.

YEAR 2 (Terms 3 & 4) :

A demonstration to the class as a whole will be appropriate in term 4 to introduce the students to a series of situations covering ship aspects in the form of lights and shape, and a simple outline of steering and sailing rules.

YEAR 3 (Terms 5 & 6) :

In term 5, a short demonstration exercise will be provided for the students relating to case studies covering the application of lights, shapes and sound signals.

In term 6, the training programme will involve a comprehensive look at the steering and sailing rules, and the importance of maintaining a lookout, safe speed, ascertaining risk of collision, and the application of special circumstances. The introduction of short practical exercises on the shiphandling simulator to deal with the situations that arise in cases of collision in the open sea and practices to be carried out on the bridge as a watchkeeper, will be given.

YEAR 4 (Terms 7, 8 & 9):

In this year, the nautical training programme involves the theoretical aspects of handling a vessel, reacting to emergencies and exceptional circumstances, and using such facilities as tugs, bow thrusters and anchors to assist in manoeuvring operations. At this stage students have completed their basic radar observer course as well as covering certain navigation aids such as logs, echosounder, and radio communication procedures.

In term 7 and term 8, the student is exposed to the duties of watchkeeper. Therefore, he is becoming involved in the principles of voyage planning, particularly in coastal waters, monitoring the passage, and being aware of the behaviour of the ship in restricted visibility. The use of traffic separation schemes upon his operations is explored. Many of these aspects are covered by exercises on the radar simulator. A series of exercises will be introduced on the ship simulator concurrently with the radar simulator exercises programmed in to term 7 and term 8.

In term 9, the students become involved in the operation of a vessel within restricted waters. Accordingly an awareness of the bridge team and its importance to the safety of the vessel, together with passage planning with restricted waters, comes to the fore.

A series of exercises on the shiphandling simulator will provide intensive tests at this final stage on basic watchkeeping skills, further shiphandling practice and a final evaluation of the student's understanding of the collision avoidance regulations.

5.1.2 Upgrading Training Programme for Masters

At VMU, the Upgrade Training Programmes for Masters (the master classes I and II) have been designed on the basic offering them for senior officers once a year. The syllabus of the training programmes is given in appendix I. The objective of the training course is to prepare participants for the examinations for the award of certificate of competency as first and second class master mariners. The training programme is spread over 20 weeks consisting of 16 weeks of theory and 4 weeks of examination. Though the training programme for the first class masters is slightly different from the one for the second class masters, both training programmes have common subjects with the same duration. These can thus be conducted within one class with the purpose of reducing the training costs and overcoming the problem of a small number of participants. In these training programmes no differences have been recognised in the subject of Regulations for Preventing Collisions at Sea (COLREG) and manoeuvring using the same course length of 50 hours. Therefore, the proposed SHS training programme below will be designed to accommodate those who participate in both the first master or the second master certificate course.

Taking into account the experience levels of such students, the simulator will be capable of providing a major training input for candidates at this level. The SHS training programme will be integrated into the 20 week-training courses for those students.

The aims of the SHS training course will bring about a greater appreciation of the physical forces involved in ship motion and handling the operation of ships in confined waters and dealing with emergency procedures that may arise including more difficult close quarter situations. In particular the officers attending this course should be able to demonstrate an understanding and practical capability of the following aspects:

a> Shiphandling; appreciation of the forces involved and influencing factors such as weather, tide, current, wind, restricted water, head reach, stopping distance, squat, interaction, berthing with or without the assistance of tugs, pilot embarkation and disembarkation procedures, berthing manoeuvres including approaches to buoys and anchorage, the use of tugs, and stopping and manoeuvring capabilities of different types of vessels.

b> Emergency procedures; how to respond to emergency situations including man overboard, handling of ships in heavy weather, picking up survivors from the sea, and action to be taken following a collision or grounding.

c> Collision avoidance; to monitor the traffic situation through the use of the bridge team, and to take necessary effective action in day/night/fog conditions of visibility both as a stand-on and as a give-way vessel. The Situation may include head-on, crossing, overtaking situation, meeting in narrow channels, multi-ship encounters including special circumstances, and the proper use of manoeuvring and warning signals.

d> Utilisation of resources of manpower and equipment in conducting all aspects of navigation.

5.2 WATCHKEEPER TRAINING PROGRAMME FOR BACHELOR IN NAUTICAL SCIENCE

The use of the shiphandling simulator will be directed towards providing practical experience of those seamanship and navigation skill, which the student is expected to demonstrate an understanding and competency in for both a watchkeeping certificate and the award of a diploma. This will involve meeting several major training objectives.

5.2.1 Training Objectives

1. To provide students with a broad understanding of the principles of safe navigation in open and restricted waters, including the recognition and use of lights, marks and buoyage systems.

2. To develop a practical understanding in the application of the collision avoidance regulations in day and night traffic

situations.

3. To establish good watchkeeping standards and practices on the bridge in traffic situations, when navigating in restricted waters, and within port confines.

4. To extend the understanding of shiphandling theory by providing experience of practical ship manoeuvres and other seamanship skills.

5. To provide the trainee with experience of reacting to simple emergency situations.

5.2.2 Training Programme

The aim of the training programme is directed towards providing the student with a fundamental grasp and understanding of those critical practical skills in seamanship and navigational safety by which he will be adjudged competent at a later date. The tasks providing the students with such experiences must be capable of being simulated to a high degree of fidelity, and be designed to give maximum student involvement.

Investigating the syllabus for the bachelor students, taking into account the capability of the proposed shiphandling simulator at VMU, the following tasks best lend themselves in meeting the foregoing criteria.

1. Maintain a bridge watch at sea in all conditions of visibility and ensure the safe navigation of the ship in ship traffic situations.

2. Conn the ship safely with the use of recognized helm orders.

3. Approach an anchorage and bring a ship to a single anchor.

4. Enter and make a passage in a buoyed channel.

5. Use correctly the communications systems on the bridge for ship to shore, ship to ship, and internal purposes.

6.Turn a single screw vessel short round in a channel (no wind or current).

7. Turn a twin screw vessel in a channel (no wind or current).

8. Berth or unberth a vessel (single or twin screw) without tug assistance with or without bow thruster (no wind or current).

9. Respond to simple emergency situations such as man overboard, engine failure or malfunction in equipment.

The shiphandling simulator programme will be integrated with the radar simulator training programme for the bachelor running concurrently in terms 5,6,7,8 and 9. The latter deals particularly with restricted visibility navigation and the importance of passage planning and bridge team work for safe navigation. The experiences gained from exercises of these two training programmes will complement each other. To save time on the ship simulator, with the purpose of utilizing the facility in the most effective way, all basic radar observer and ARPA training will be conducted on the radar simulator.

The following programme is based on a class size of 24. Individual exercise groups will take up duties as follows:

- **Term 5** : Student Number = 4: OOW, Lookout and visual navigation, radar anti collision, helmsman.
- **Term 6** : Student Number = 4: OOW, assistant navigator, lookout/radar anti collision, helmsman.
- **Terms 7 & 8** : Student Number = 3: OOW, radar navigation, helmsman.
- **Term 9** : Student Number = 4: As per term 6.

Assessment (shiphandling) : Student Number = 2: Shiphandler, helmsman.

The details of the proposed SHS training programme are given as follows :

BACHELOR IN NAUTICAL SCIENCE
SHIPHANDLING TRAINING PROGRAMME
YEAR 2 - TERM 4

SUBJECT : Navigation Safety.

TRAINING OBJECTIVE : To provide a visual appreciation of buoyage systems, navigational marks and lights, and ship aspects in day and night conditions, before students proceed to sea.

SIMULATOR ASSESSMENT : None

TRAINING HOURS PER STUDENT : Total = 1.5. As OOW = Nil.

PROGRAMME DETAIL : Table 5.2.

TOTAL NUMBER OF STUDENTS : 24

Table 5.2

Ex No	Time for Ex	Students on each Ex	Ex.runs per group	No of Groups	Total hrs	Exercise description
1	1.5	6	1	4	6	Demonstration exercise of basic colregs situations,buoy light systems & the simulator.

SUGGESTED TIMETABLING : 1 day towards end of semester.

****

YEAR 3 - TERM 5

SUBJECT : Navigational Safety

TRAINING OBJECTIVE : To provide experience of keeping a safe navigational watch at sea in busy traffic conditions during both day and night.

SIMULATOR ASSESSMENT : None

TRAINING HOUR PER STUDENT : Total= 4 hours. As OOW = 0.5 Max.

PROGRAMME DETAILS : Table 5.3.

TOTAL NUMBER OF STUDENTS : 24

Table 5.3

Ex No	Time for Ex hrs	Students on each Ex.	Ex.runs per group	No of groups	Total hrs	Exercise description
2	2*	4	1	6	12	Traffic situation: Tokyo bay.Day 6 traffic Vls
3	2*	4	1	6	12	Watchkeeping: Singapore.Day /night.No fog Radar plots.
				TOTAL =	24	

* Passage planning will be carried out by students prior to the exercise.

SUGGESTED TIMETABLING :

This programme will be conducted over a period of 2 weeks (weeks 13-14 of year 3). Each week the exercise will be run every Monday, Wednesday and Friday afternoon.

24 students will be divided into 6 groups : A1, A2, B1, B2, C1, C2. Each group will have 4 hours for one exercise :

- 1.5 hours for Preparation
- 2 hours for Exercise
- 0.5 hour for Debriefing.

The schedule is given in table 5.4.

Table 5.4

Time	13.00 - 17.00	15.00 - 19.00
Monday	A1	A2
Wednesday	B1	B2
Friday	C1	C2

Note : When the first group runs exercises on the shiphandling simulator until 16.30, the second group will prepare for the exercise from 15.00 to 16.30. After that the second group will take over the shiphandling simulator for exercise, and the first group will have a debriefing of the exercise in the debriefing room.

****

YEAR 3 - TERM 6

SUBJECT : Navigational Safety

TRAINING OBJECTIVES : To provide each student with experience as OOW, using the bridge team to support decision making processes in more difficult traffic situations, navigating through traffic separation areas with intermittent reduced visibility by day or night.

SIMULATOR ASSESSMENT : None

TRAINING HOURS PER STUDENT : Total = 12 hrs. As OOW = 3 hrs Max.

PROGRAMME DETAILS : Table 5.5

TOTAL NUMBER OF STUDENTS : 24

Table 5.5

Ex No	Time for Ex hrs	Students on each Ex	Ex. runs per Group	No of Groups	Total hrs	Exercise description
4	2*	4	2	6	24	Singapore Passage, each student acts as OOW. 6 targets Vls. Day with some mist.
5	2*	4	2	6	24	Navigation through Termination Pick up pilot. Day/night.
6	2*	4	2	6	24	Tokyo Bay. Anchor vessel, heave up, enter ports. 4 target ships. Wind, tide, daylight.
				TOTAL =	72	

* Passage planning will be carried out by students prior to the exercise.

SUGGESTED TIMETABLING

The programme will be conducted over 6 weeks (12 hours per week). These are weeks 21, 22, 23, 24, 25, 26 of year 3.

24 students will be divided into 6 groups, namely A1, A2, B1, B3, C3, C4. Each group will have 4 hours on the ship simulator as follows :

- 1.5 hours for Preparation
- 2 hours for Exercise
- 0.5 hour for Debriefing.

The schedule is the same as the one given in table 5.4.

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YEAR 4 - TERMS 7,8

SUBJECT : Practical Shiphandling.

TRAINING OBJECTIVES : To extend the understanding of shiphandling theory gained during the terms by experience of practical ship manouevres within port confines.

SIMULATOR ASSESSMENT : Continuous

TRAINING HOURS PER STUDENT: Total = 9 hrs. As Shiphandler= 3 hrs

PROGRAMME DETAILS : Table 5.6.

TOTAL NUMBER OF STUDENTS : 24

Table 5.6

Ex No	Time for Ex hrs	Students on each Ex	Ex.run per Group	No of Groups	Total hrs	Exercise description
7	1	3	3	8	24	Turn single screw ship short round; bring to single anchor.
8	1	3	3	8	24	Berth a single screw ship with or without thruster.
9	1	3	3	8	24	Turn and berth twin screw ship.

TOTAL = 72

SUGGESTED TIMETABLING :

Exercises No 7 & 8 will be carried out in 8 weeks of term 7. These are weeks 1, 2, 3, 4, 5, 6, 7, and 8 of year 4.

Exercise No 9 will be carried out in 4 weeks of term 8. These are weeks 17, 18, 19 and 20 of year 4.

24 students will be divided into 8 groups namely A1, A2, B1, B2, C1, C2, D1, D2.

Each group will have 3 hours on the ship simulator per week:

- 1 hour for Preparation
- 1 hour for Exercise
- 1 hour for Debriefing.

The schedule is given in table 5.7 as follow:

Table 5.7

Time	14.00 - 17.00	15.00 - 18.00
Monday	A1	A2
Wednesday	B1	B2
Friday	C1	C2

Note : Groups D1 and D2 will replace A1 and A2 respectively in Monday of the week 2. Groups A1 and A2 will move to Wednesday. B1 and B2 to Friday. These groups will rotate their time on the simulator the following weeks as follows.

Week Number:	1	2	3	4	5	6	7	8	17	18	19	20
Monday :	A	D	C	B	A	D	C	B	A	D	C	B
Wednesday :	B	A	D	C	B	A	D	C	B	A	D	C
Friday :	C	B	A	D	C	B	A	D	C	B	A	D

Note : A = A1, A2 ; B = B1, B2 ; C = C1, C2.

****

YEAR 4 - TERM 9

SUBJECT : Navigation Safety/ship manoeuvring.

TRAINING OBJECTIVE : To provide experience of watchkeeping, navigation and ship control in difficult weather conditions or emergency situations, making full use of all navigational instruments and aids.

SIMULATOR ASSESSMENT : Continuous

TRAINING HOURS PER STUDENT: Total = 9 hrs. As OOW = 2.25 hrs.

PROGRAMME DETAILS : Table 5.8

TOTAL NUMBER OF STUDENTS : 24

Table 5.8

Ex No	Time for Ex hrs	Students on each Ex	Ex. run per group	No of Groups	Total hrs	Exercise description
10	1.5	4	4	6	36	Tokyo Bay.Day,6 targets ships. Wind,tide. some difficult situations.
11	1.5*	4	2	6	18	Emergency procedures:MOB, power or equipment failures.

TOTAL = 54

* Passage planning by groups prior to exercise.

SUGGESTED TIMETABLING :

This will be carried out in the 6 following weeks : 30, 31, 32, 33, 34, 35 of year 4.

The 6 groups will be A1, A2, B1, B2, C1, C2. Each group will have 3 hours at the ship simulator:

1 hour for Preparation
1.5 hour for Exercise
0.5 hour for Debriefing

The schedule is given in table 5.9 as follow:

Table 5.9

Time	13.30 - 16.30	15.00 - 18.00
Monday	A1	A2
Wednesday	B1	B2
Friday	C1	C2

ASSESSMENT ON SHIPHANDLING SKILLS

At the end of term 9, when students have completed the training programme on the ship simulator, it would be possible to assess each student by means of a short exercise. The class of 24 students will be divided into 12 groups. The assessment will be conducted in two weeks, 37 and 38, of year 4. The first six groups (A1-A6) will be assessed in week 37. The second six groups (A7-A12) will be assessed in week 38. The schedule is given in table 5.10 as follows.

Table 5.10

WEEK 37	14.00 - 16.00	16.30 - 18.30	WEEK 38	14.00 - 16.00	16.30 - 18.30
MON	A1	A2	MON	A7	A8
WED	A3	A4	WED	A9	A10
FRI	A5	A6	FRI	A11	A12

THE SUMMARY OF THE PROPOSED SHS TRAINING PROGRAMME FOR THE BACHELOR IN NAUTICAL SCIENCE

1. TOTAL HOURS.

YEAR	TERM	NAVIGATIONAL SAFETY	SHIPHANDLING/ SEAMANSHIP
2	4	6	-
3	5	24	-
3	6	72	-
4	7	-	48
4	8	-	24
4	9	54	-
	TOTAL	156 *	72

* a considerable percentage of this time involves ship manoeuvring experience.

2. INDIVIDUAL HOURS

YEAR	TERM	NAVIGATIONAL SAFETY	AS OOW	SHIPHANDLING SEAMANSHIP	AS SHIPHANDLER
2	4	1.5	-	-	-
3	5	3.5	0.5	-	-
3	6	9	3	-	-
4	7 & 8	-	-	6	3
4	9	6.75	2.25	-	-
	TOTAL	20.75	5.75	6	3

USAGE OF SHIPHANDLING SIMULATOR : PROJECTED WEEKLY HOURS.

WEEK	YEAR 2	YEAR 3	YEAR 4	TOTAL Hours	TOTAL Sessions
1			6	6	6
2			6	6	6
3			6	6	6
4			6	6	6
5			6	6	6
6			6	6	6
7			6	6	6
8			6	6	6
9					
10					
11					
12					
13		12		12	6
14		12		12	6
15					
16					
17			6	6	6
18			6	6	6
19			6	6	6
20			6	6	6
21		12		12	6
22		12		12	6
23		12		12	6
24		12		12	6
25		12		12	6
26		12		12	6
27					
28					
29	6			6	4
30			9	9	6
31			9	9	6
32			9	9	6
33			9	9	6
34			9	9	6
35			9	9	6
36					
37			18	18	6
38			18	18	6
39					
40					
TOTAL	6	96	172	274	172

NOTE :

- Session is defined as one time of completing one exercise per group.

- The total of 274 hours is running simulator exercise hours without calculating time for preparation and debriefing.
- The above training programme is mainly conducted during the afternoons of every Monday, Wednesday and Friday for one class of 24 students. Thus, in case there are two classes of 48 students (each class has 24 students), the same programme can be used for both classes. One class will make use of the ship simulator every Monday, Wednesday and Friday afternoon and the other will make use of the ship simulator in the mornings of the same days.
- On the other three days in the week (Tuesday, Thursday and Saturday), students will practise on the part-task simulator programmes. The training programme on Radar/ARPA simulator will be designed concurrently in terms 6,7,8 and 9. The purpose is to reduce the load on the ship simulator and the experiences gained from these training programmes will complement each other.
- In order to make effective use of the training programme, some subjects currently programmed would be rescheduled. For example, the lectures on Regulations for Preventing Collision at Sea, currently programmed in term 6, would be rescheduled into term 4.

5.3 SHIPHANDLING TRAINING PROGRAMME FOR SENIOR OFFICERS

Below is a SHS Training Programme proposed for the Master Mariner class I certificate at VMU. Based on the experience level of the students, the SHS training programme is designed to allow the students to develop an understanding of the handling characteristics of various sizes of ship, and how to control the ship when environmental forces are present.

5.3.1 Training Objectives

The training objectives of the programme are given as follows:

1. To provide experience of basic shiphandling manoeuvres within port confines.

2. To provide a basic understanding of the effect of environmental forces upon the behaviour of a ship, and to give experience of reacting to them.

3. To provide visual and physical experiences of shallow water and iteraction effects upon own-vessel.

4. To provide some practical experience in the use and control of tugs in simple berthing manoeuvres.

5. To control the safe navigation of the ship in difficult traffic situations and adverse weather conditions.

6. To provide experience of responding to emergency situations.

5.3.2 Training Programme

Investigating the syllabus for the Master Mariner class I level, taking into account the capability of the proposed shiphandling simulator at VMU and the constraints of limited time, and the number of students involved, the following tasks best lend themselves in meeting the foregoing criteria.

1. Apply the manoeuvring characteristics of ships to shiphandling operations.

2. Anchor or moor a vessel with influencing environmental effects.

3. Pick up or drop a pilot, with own-ship and pilot vessel under the influence of wind and/or current.

4. Control and manoeuvre own-ship safely in narrow channels.

5. Berth and unberth a vessel (single-or twin-screw) with environmental forces.

6. Use tugs in simple shiphandling and/or berthing operations.

7. Be called to the bridge by the OOW to take over in a difficult traffic situation and adverse weather conditions.

8. Respond to emergency situations such as engine failure, steering loss, power failure, man overboard, malfunction of bridge equipment and navigational aids.

The programme is based on a class size of 24. The number of students attending the programme will be organised as follows :

- For shiphandling exrcises, the size of the exercise group will be 3 trainees, the duties being divided as master, OOW and helmsman.
- For the navigation exercises, the size of the exercise group will be 4 students with the duties being master, chief mate (radar collision avoidance), OOW (lookout/navigation) and helmsman.

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

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

The details of the training programme are as follows :

MASTER MARINER CLASS I
SHIPHANDLING SIMULATOR TRAINING PROGRAMME

NAUTICAL KNOWLEDGE : SHIPHANDLING, SEAMANSHIP AND NAVIGATIONAL SAFETY.

SUBJECT : Shiphandling and navigational safety.

TRAINING OBJECTIVE : To provide experience of basic shiphandling and berthing manoeuvres under the influence of environmental forces, and give experience of decision making by the master in difficult risk of collision encounters and in emergency situations.

SIMULATOR ASSESSMENT : None

TRAINING HOUR PER STUDENT : Total = 13 As Master = 4

PROGRAMME DETAILS : Table 5.11

TOTAL NUMBER OF STUDENTS = 24

Table 5.11

Ex No	Time for Ex hrs	Students on each Ex	Ex. runs per Group	No of Groups	Total hrs	Exercise description
1	1*	4	4	6	24	Keppel to Yokohama.6 target ships.wind x 5/6. Cross current. 2 runs by day then 2 by night.
2	1.0	3	3	8	24	Turn short round and anchor with wind & tide. Keppel harbour.
3	1.0	3	3	8	24	Enter Yokohama, swing, berth. Flood tide (2 runs day/night). Depart Yokohama, swing,ebb tide, (2 runs-day/night). Some emergency procedures.
4	1	3	3	8	24	Depart Yokohama using 3 tugs. Flood, strong winds, drop pilot out side. Some emergency procedures.
				TOTAL =	96	

* Passage planning by groups prior to exercise.

- Scenario for exercises 2,3,4 will be handed to students one week before running for planning of manoeuvres.

- Before conducting exercise No 1, 24 students will be divided into 3 groups of 8 for running familiarisation exercise No 1. Each group will have 1 hour on the ship simulator.

Thus the total hours on the ship simulator = 99 for the whole training programme.

SUGGESTED TIMETABLING :

The total of 99 hours for the training programme will be carried out over 11 weeks. Each week, 9 exercises will be run every Tuesday, Thursday and Saturday afternoon. This means, on each afternoon, 3 exercises will be conducted. They will be scheduled as follows :

- 0.5 hour for Preparation
- 1 hour for Exercise
- 0.5 hour for Debriefing.

Thus, on each afternoon :

* From	13.00 - 13.30 :	Preparation for the first group
	13.30 - 14.30 :	Exercise for the first group
* From	14.30 - 15.00 :	Debriefing for the first group and Preparation for the second group
	15.00 - 16.00 :	Exercise for the second group
* From	16.00 - 16.30 :	Debriefing for the second group and Preparation for the third group
	16.30 - 17.30 :	Exercise for the third group
	17.30 - 18.00 :	Debriefing for the third group.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

'... The golden rule is where it all begins and ends.'
(James R.Fisher)

6.1 CONCLUSIONS

The shiphandling simulator now being used worldwide is more and more becoming an effective and useful tool for the training of mariners. The rapid growth and development of the simulator has been recognised during the last 25 years. From a simple model in design with limited functions, the shiphandling simulator has become a very sophisticated model with extensive functions and a useful tool for research and training purposes.

The shortcomings of training due to the lack of marine simulators is well recognised by Vietnam Maritime University. In order to increase the effectiveness of training, to keep up and improve the standard of Vietnamese navigating officers as required by IMO STCW's - 78 convention, a plan for installing marine simulators including SHS at VMU has been carried out.

The shiphandling simulator is a computerized system which can be used for various nautical training objectives such as watchkeeping training, emergency response training, improvement of bridge organization, development of ship handling techniques, collision avoidance situations and research purposes. It evolved from the need to simulate, as closely as possible, the ship and its natural environment and the work that has to be done by the bridge team members.

The main elements of a SHS system are bridge, control station, visuals, mathematic model and computer peripherals interface. From the user's point of view, the major and most important component of a shiphandling system is the visual system. Due to the rapid development in technology, a number of visual systems have been introduced such as the shadowgraph, the model board, the slide projection, the nocturnal display, the C.G.I visual display and the latest development - the laser video disk. Today, the C.G.I visual display is exclusively used due to its better features.

The Bridge Wing Simulator, a new application of existing technology, is designed to overcome the existing limitations of the present shiphandling simulator. It provides a correct view for the shiphandling trainee who is attempting to build shiphandling judgement.

Recent developments in micro - computers make it possible to perform complicated simulation processes by using small computer systems. This development has been adopted for use in the small world of large-scale ship manoeuvring simulators. The main advantages of the system is its cost effectiveness and simplicity compared to a simulator with a mock-up of the ship's bridge and a system to produce a realistic outside view.

The shiphandling simulator is very flexible for training purposes ranging from the training of cadets up to the level of training senior officers, master mariners and pilots. However, the effectiveness of the training on the simulator is based on the proper utilization of the training facility. It means it depends upon the proper design of the training programme and the effective conduct of the training programme in the training process by the instructors.

In designing the SHS training programme, due attention should be paid to the constraints of limited time, number of students, and the capabilities of the available shiphandling simulator. It is clear that the technology can provide a highly effective and realistic training medium for the mariner. The range of tasks that can be produced is comprehensive, depending upon the sophistication of the equipment. However, the number of training objectives and individual tasks that can be included in any programme is restricted due to the above mentioned constraints. Therefore, it is very important for the designer of the training programme in structuring simulator courses to identify those aspects of maritime training that will produce the maximum benefit to both mariner and industry. Other part-task trainers should be fully integrated into any simulator training programme, leaving the ship simulator to use its capability to focus on specific tasks.

A brief look at the SHS training programmes in selected maritime training centres shows the effectiveness of the application of SHS in training purposes. These well structured programmes, with clear aims and objectives, with help to create a proposed SHS training programme for VMU.

The proposed training programme will support the completion of the plan of utilizing mariner simulators at VMU. Since the programme runs parallel with the current training schedule, the academic studies will be strongly supported. When the eventual use of the SHS is integrated within the VMU syllabus, theoretical lectures can be reduced to a certain extent.

Nevertheless, the ship simulator cannot replace reality. Therefore, in the maritime education and training of mariners, there is a need to compromise when using the ship simulator and when training on board ships.

So far, a number of international conferences on marine simulation (MARSIM) have been realized. All aspects of ship simulators have been discussed in order to improve the effectiveness in utilizing the facility in training mariners on an international scale. However, no international requirements and standards on using ship simulators have been recognised. Therefore, there should be international requirements and standards on using ship simulators adopted by IMO.

6.2 RECOMMENDATIONS

Subsequent to the given conclusions, the following recommendations are made :

The proposed SHS training programme should start from 1994 after finishing the installation of the simulator and the training of instructors.

The afternoon non-academic activities for the second, third and fourth year students of the nautical department should be rescheduled in connection with the suggested timetabling in the proposed training programme.

Some subjects currently programmed should be rescheduled in connection with the process of the proposed training programme.

Initially, for a trial period, the cadets should not be examined until the full integration of the SHS training into the main stream programme.

The instructors who will conduct the shiphandling training courses should have the highest professional certificate of competency and should undergo specialized course training on the ship simulator provided by the simulator manufacturer.

The University should provide the instructors with opportunities to participate in the International Conference on Marine Simulation (MARSIM) so that they can exchange information regarding the SHS training and improve themselves in conducting training courses on the simulator.

During the shiphandling simulator training course a competent technician should be available with the capability to maintain, correct and carry out minor repairs. He/she should be trained by the simulator manufacturer in the maintenance and repair of equipment.

The shiphandling simulator should be equipped with GMDSS equipment and Electronic Navigation chart. The areas of exercises should be expanded to include domestic port areas.

Provision of necessary staff for scheduled time periods of proposed training should be made. The requirement for this would be 2 simulator operators doing the nautical instructor's tasks as well.

All records of participants and feedback from them should be maintained for future analysis. It is necessary to improve and update the SHS training programme with time.

Besides the proposed SHS training programmes for the watchkeeping level and master mariner level, the SHS training programmes should be designed for other trainees on request (e.g. pilots, VTS-operators,etc.).

The ship simulator should be utilized not only for training purposes, but for research purposes as well.

BIBLIOGRAPHY

'Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it.'
(Johnson)

Carpenter, M.H. (1987), Commentary on the capability of ship simulators for the nineteen nineties. Proceedings 4th International Conference on Marine Simulation (MARSIM 87), Trondheim.

Froese, J., Sander, C. (1984), The "Full Mission" ship simulator as a teaching tool training theory and its practical application. Proceedings 3rd International Conference on Marine Simulation (MARSIM 84), Rotterdam.

Froese, J., Maanen W.Ph., Douglas, D. (1990), International co-operation on the use of simulation for pilot training. Proceedings Joint International Conference on Marine Simulation and Ship Manoeuvrability (MARSIM & ICSM 90), Tokyo.

Gardenier, J.S., Hammell, T.J. (1981), Shiphandling simulator standards and training technology. Proceedings 2nd International Conference on Marine Simulation (MARSIM'81), New York.

Guest, F.E. (1990), The bridge wing shiphandling simulator. Proceedings Joint International Conference on Marine Simulation and Ship Manoeuvrability (MARSIM & ICSM 90), Tokyo.

Gong, I.Y., Kim, S.Y., Kang, C.G., Park, H.C. (1990), Development and application of an on-board manoeuvring simulator. Proceedings Joint International Conference on Marine Simulation and Ship Manoeuvrability (MARSIM & ICSM 90), Tokyo.

Gynther, J.W., Hammell, T.J., Grasso, J.A., Pittsley, V.M. (1982), Development of a simulator functional specification for maritime cadet training. Simulators For Mariner Training and Licensing: Functional Specifications and Training Program Guidelines For a Maritime Cadet Simulator. Report No 50-8004-02, CAORF, New York.

Hammell, T.J. (1981), The training device is more than a simulator. Proceedings 2nd International Conference on Marine Simulation (MARSIM'81), New York.

Hammell, T.J. (1984), Bridge simulator training system differences: third mate - pilot. Proceedings 3rd International Conference on Marine Simulation (MARSIM 84), Rotterdam.

Hard, D.A., Guest, F.E. (1981), A training philosophy for maritime simulator training. Proceedings 2nd International Conference on Marine Simulation (MARSIM'81), New York.

Hamburg Fachhochschule. (1993), Shiphandling Simulator Training Programmes SUSAN SS'93, Hamburg.

Hansford, R.F. (1978), A versatile simulator for training and research. Proceedings 1st International Conference on Marine Simulation (MARSIM 78), Southampton.

Lodhi, P.K. (1991), Proposed Training of Cadets on the Shiphandling Simulator of the Pakistan Marine Academy (Unpublished Dissertation, World Maritime University), Malmö.

Meurn, R.J. (1984), Equivalency of simulator exercises in meeting IMO training standards for real-world experience. Proceedings 3rd International Conference on Marine Simulation (MARSIM 84), Rotterdam.

Meurn, R.J. (1987), Part and whole task training to improve cadet watchstanding skills - The role of the instructor. Proceedings 4th International Conference on Marine Simulation, Trondheim.

Meurn, R.J.(1993), Ship simulator bridge and control station requirements from an instructor's point of view. Proceedings International Conference on Marine Simulation and Ship Manoeuvrability (MARSIM'93), Newfoundland.

Moriya, S., Hirano, M.(1990), Development of a desktop simulator and its application of simulator link. Proceedings Joint International Conference on Marine Simulation and Ship Manoeuvrability (MARSIM & ICSM 90), Tokyo.

Muirhead, P.M.P.(1984), Developing a Training profile for the Krupp-Atlas shiphandling Simulator at the Australian Maritime College, Australian Maritime College.

Muirhead, P.M.P.(1985), The Growth and Development of Shiphandling Simulator Systems from Training Device to Assessment Tool - An Investigation, Unpublished MSc. Thesis, University of Wales Institute of Science and Technology.

Muirhead, P.M.P.(1987), The assessment of shiphandling skills on the ship simulator: --a practical approach. Proceedings 4th International Conference on Marine Simulation (MARSIM 87), Trondheim.

Muirhead, P.M.P.(1993), Marine simulation performance measurement and assessment: methodologies and validation techniques - A critique, Proceedings International Conference on Marine Simulation and Ship Manouevrability (MARSIM'93), Newfoundland.

Otagaki, Y. Nitta, T., Takagi, E.(1990), On-board system for maneuvering plan. Proceedings Joint International Conference on Marine simulation and Ship Manoeuvrability (MARSIM & ICSM 90), Tokyo.

Puglisi, J.J.(1987), History and future development in the application of marine simulators, Tomorrow's challenging role for the International Marine Simulator Forum (IMSF). Proceedings 4th International Conference on Marine Simulation (MARSIM 87), Trondheim.

Suu, T.D.(1991), ARPA Training in Vietnam; Implementation and Certification (Unpublished Dissertation, World Maritime University), Malmö.

Vietnam Maritime University.(1992), The Nautical Syllabus of Vietnam Maritime University. Haiphong.

Vietnam Maritime University.(1992), Documents on the proposed shiphandling simulator at VMU. Haiphong.

Zade, G.(1978), Cost and benefit of nautical simulators - A user's point of view. Proceeding 1st International Conference on Marine Simulation, Southamption.

APPENDIX I

THE NAUTICAL SYLLABUS OF VIETNAM MARITIME UNIVERSITY

I.1 NAVIGATION DEPARTMENT

Training duration : 5 years
Lectures : 119 weeks
Practice : 42 weeks (25 weeks of graduation practice included)
Graduation thesis and graduation exams : 16 weeks

SUBJECT	CLASS HOURS
1. Philosophy	90
2. Economics	90
3. History	60
4. Geography	50
5. English	410
6. Physical education	120
7. Advanced Mathematics	300
8. Nautical Mathematics	105
9. Physics	201
10. Chemistry	75
11. Descriptive geometry	60
12. Technical drawings	30
13. Theoretical mechanics	120
14. Fluid mechanics	70
15. Thermal technology	60
16. Informatics	75
17. Strength of materials	90
18. Electrical technology and marine electricity	146
19. Radio technology	90
20. Fundamentals of seamanship	60
21. Ship structure and maintenance	186
22. Automation	84
23. Ocean meteorology	84
24. Maritime safety	60 (90 *)

25.	Magnetic compass	56
26.	Sea transport economics	153
27.	Manoeuvering and collision avoidance	117
28.	Maritime laws and insurance	109
29.	Cargo work	88
30.	Navigation	219
31.	Maritime astronomy	146
32.	Electronic navigation aids	269
33.	ship engine	78
	Total	3,960

+ Shipboard practice divided into :
  - Seamanship training : 17 weeks
  - Graduation practice : 25 weeks

+ Graduation requirements :
  - Graduation paper.
  - Exam in English.
  - Exam in Navigation subjects
  - Exam in Electronic navigation aids
+ In 1st and 2nd year students study six days a week, in 3rd and 4th year five days a week, 6 hours a day.

Note :

* Class hours when the project is completed.

I.2 UPGRADING TRAINING PROGRAMME OUTLINE FOR MASTER

I.2.1 The Programme for the First Class Master

1.	Navigation	50	hours
2.	Astronomy	40	-
3.	Meteorology	20	-
4.	Radar observation and plotting	40	-
5.	Maritime Safety / Pollution Prevention MARPOL - 73/78 ANNEX 1, ANNEX 2	60	-
6.	Port state control	25	-
7.	Maritime Search and Rescue	30	-

8.	Marine Radio equipment	25	-
9.	Marine Aids to Navigation	25	-
10.	Regulations for preventing collision at sea (COLREG) and manoeuvering	50	-
11.	Marine commerce	40	-
12.	Maritime law and ship's business for master	40	-
13.	Marine insurance	20	-
14.	Cargo handling	25	-
15.	Informatics	20	-
16.	Seminar	20	-
	Total	545	hours.

I.2.2 The Programme for the Second Class Master

1.	English	100	hours
2.	Navigation and tide	40	-
3.	Astronomy	30	-
4.	Meteorology	20	-
5.	Ship's engine	15	-
6.	Ship's electricity	15	-
7.	Marine Aids to navigation	30	-
8.	Marine Radio equipment	30	-
9.	Regulations for preventing collision at sea and manoeuvering (COLREG)	50	-
10.	Marine commerce	40	-
11.	Maritime Law and ship's business for master	40	-
12.	Marine insurance	25	-
13.	Cargo handling	30	-
14.	Informatics	35	-
15.	Ship's radar	40	-
16.	Seminars	15	-
	Total	555	hours

Equivalent to 16 weeks of theory, 4 weeks of exam.

APPENDIX II

DEVELOPMENT OF SHIPHANDLING SIMULATORS 1967-1993

No	Name and location	Year Open	Type	Manufacturer
1.	SSPA, Göteborg, Sweden	1967	CGI/TV	SSST
2.	SMS, TNO-Delft, Netherlands	1968	Shadowgraph	IWECO-TNO
3.	MARIN, Wageningen, N'Lands	1969	Shadowgraph	IWECO-TNO
4.	SSS, Hiroshima Uni, Japan	1971	Film project'n	University
5.	SS Bremen, W.Germany	1975	Slide projectn	VFW-Fokker
6.	IHI, Tokyo, Japan	1975	Slide projectn	IHI/NAC
7.	SHS, Osaka Uni, Japan	1975	Shadowgraph and TV	University
8.	Navy, DenHelder, Netherlands	1975	Nocturnal	Navy
9.	TNO-Soesterberg, Netherlands	1976	Modelboard	TNO
10.	CAORF, K.Pt, New York, USA	1976	CGI	Sperry
11.	Marine Safety Int, New York,USA	1976	Modelboard	Sperry
12.	MARIN, Wageningen, Netherlands	1976	Nocturnal	TNO
13.	Warsash College, S'Ton, UK	1977	Nocturnal	Decca
14.	Maritime Uni, Tokyo, Japan	1978	Shadowgraph	NAC/Uni
15.	NLS, Bremen, W.Germany	1978	Nocturnal	VFW-Fokker
16.	Mitsubishi, Nagasaki, Japan	1978	Slide Projectn	MHI
17.	Ship Analytics. N.Stonington, USA	1979	CGI	Ship Analytics
18.	SMS Trondheim, Norway	1979	Nocturnal	VFW-Fokker
19.	Danish Mar.Inst, Lingby, Denmark	1980	CGI/TV	DMI
20.	Warsash College, S'Ton, UK	1981	Nocturnal	Decca
21.	MITAGS, Baltimore, USA	1981	Nocturnal (2)	VFW-Fokker
22.	Shipsim, S.Shields College, UK	1982	Nocturnal	Decca
23.	CASSIM, UWIST Cardiff, Wales	1982	CGI/Tepigen	Marconi/Decca
24.	SUSAN, Hamburg, W.Germany	1982	CGI	Krupp Atlas
25.	Shipsim, Glasgow College, Scotland	1982	Nocturnal	Decca
26.	SMS, Trondheim, Norway	1982	Slide Projectn	VFW-Fokker
27.	RSSC, Leningrad, USSR	1983	Nocturnal	Norcontrol
28.	Marin, Wageningen, Netherlands	1983	CGI/Graphic	TNO
29.	Toledo, Ohio, USA	1983	CGI	Ship Analytics
30.	Navy, Sydney, Australia	1985	CGI	Krupp Atlas
31.	AMC, Launceston, Australia	1985	CGI	Krupp Atlas
32.	Taiwan Maritime College, Taiwan	1985	CGI	Krupp Atlas
33.	Piney Point, Maryland, USA	1985	CGI	Ship Analytics
34.	USCG, New London, Ct, USA	1985	CGI (2)*	Ship Analytic
35.	Finsim, Espoo, Finland	1986	CGI	Norcontrol
36.	Marine Technical College, Tokyo	1987	CGI/TV	MTC
37.	Navy, Kiel, W.Germany	1987	CGI	Krupp Atlas
38.	Plymouth Polytechnic, UK	1987	CGI	Racal/Decca
39.	Korean Martime Inst. Pusan,Korea	1988	CGI	Norcontrol
40.	Seamans Ch. Inst, New York, USA	1989	CGI	Norcontrol
41.	Nova Scotia Nautical Inst. Canada	1989	CGI	Norcontrol
42.	Kalmar Marine Academy, Sweden	1989	CGI	Norcontrol
43.	Bulgarian MTI, Bulgaria	1990	CGI	Norcontrol
44.	Haugesund Maritime Coll, Norway	1990	CGI	Norcontrol
45.	Danube Shipping Co. USSR	1990	CGI	Norcontrol

No	Name and Location	Year	Type	Manufacturer
46.	Danish Mar. Inst, Lyngby,Denmark	1990	CGI	DMI
47.	MTC, Ashiya, Japan	1991	CGI	n.a
48.	MSCN, Wageningen, Netherlands	1992	CGI	MSCN
49.	Marine Inst, Newfoudland, Canada	1992	CGI	Norcontrol Sim
50.	Tonsberg, Vestfold Poly, Norway	1992	CGI	Norcontrol
51.	Port of Singapore Authy, Singapore	1993	CGI	BAe. Sim Ltd

NOTES.

1. Many of the simulators listed between numbers 1 to 28 have since been upgraded to Computer Generated Imagery (CGI) status. A number of radar and navigation simulators, of which there are many fitted around the world, have been provided with add-on visuals to one of the own ship cubicles. This gives a greater capability for shiphandling exercises, although such simulators will be limited in scope compared to the full-mission shiphandling simulator. Norcontrol is at the forefront in providing lower cost visuals.

2. The simulator at University of Wales (CASSIM) was dismantled on 1/7/85 as a result of failure to keep it in operation due to funding difficulties.

3. The IHI simulator (No 6) was closed down in 1986.

4. The USCG facility at New London (No 34) includes the first purpose built bridge wing simulator. The simulators at Hamburg and Launceston can for example achieve this through software means.

(Source: P. Muirhead, MSc. Thesis, 1993)

APPENDIX III

SUMMARY OF FUNCTIONAL REQUIREMENTS FOR MARITIME CADET SIMULATOR

Critical Characteristic	Recommended Level	Additional Comments
1. Visual Scene • Time of day	Night only	Day desirable but not required Simultaneous display of: • 5 traffic vessels • 6 coastal navigation lights Background/cultural lights as appropriate for realism Silhouettes desirable but not required
• Geographic area	Coastal	Land mass > 2.0 nm distant Traffic vessels: close aboard
• Horizontal field of view	At least 180 degrees	
• Vertical field of view	At least 20 degrees	
• Color	Multi-color	
• Visual scene quality	No undesired visual effects adequate realism to accomplish training objectives	Evaluated by panel consisting of several mariners, simulation and training experts Use of binoculars not required
2. Radar Presentation	Low fidelity	Synthetic presentation 16-inch plotting surface 15 contacts (e.g., traffic vessels, aids to navigation) Coastline generation of six selected geographic areas Normal radar functions CAS functions not required Noise desired but not required
3. Bridge Configuration	Full bridge	Desire full-size pilothouse; 3M (depth) x 4M (width) minimum dimensions Gyrocompass repeaters Steering stand Propulsion control panel Visual bearing capability Speed log Depth sounding device RDF Loran-C Digital clock Chart table Radiotelephone Internal shipboard communications Ownship/traffic ship whistles
4. Ownship Characteristics and Dynamics	Deep water	Hydrodynamic model compatible with CAORF coefficients Shallow water effects desired but not required Wind and current forces required

SUMMARY OF FUNCTIONAL REQUIREMENTS FOR MARITIME CADET SIMULATOR (Continued)

Critical Characteristic	Recommended Level	Additional Comments
5. Exercise Control	Instructor exercise control	Capability to select exercise Capability to modify exercises prior to initiation Capability to alter traffic vessel motion during exercise Capability to initiate shipboard casualties during exercise Capability to freeze and restart exercises Instructor: sole system operator
6. Traffic Vessel Control	Independently maneuverable traffic	Capability to alter traffic vessel motion prior to initiation of exercise Capability to alter traffic vessel motion during exercise Traffic vessel characteristics and dynamics – simplified math model – approximate handling characteristics
7. Training Assistance Technology	Remote monitoring	Located in classroom Slave radar presentation Close circuit TV system Audio monitoring system Visual scene monitors Radiotelephone Internal ships communication Traffic vessel whistle control Simulation control
	Feedback displays	Located in classroom Minimum 3' x 3' screen Multi-color projection Three generic displays • Collision avoidance • Coastal navigation • Shiphandling Presents selected ship parameters recorded during exercise in graphic format Presents impact of alternative ownship actions Generates performance measures Generates fast-time model in classroom Hardcopy plotter desired but not required
8. Availability	Design goal: Operational training 30 hours per week with 95% availability; 10 hours per week maximum maintenance time	Best commercial manufacture One onsite technician from Academy staff Contractor to train Academy technician Maintenance/repair manual Spare inventory negotiated during initial procurement Contractor to provide one qualified technician onsite for first semester Service contract for simulator computer

APPENDIX IV

SHIP OPERATION OFFICER COURSE (SOO/SB)

WEEK 10 08-12 MARCH 1993	WEEK 12 22-26 MARCH 1993
(Full Group) Theme : Introduction - SUSAN introduction - Equipment Familiarisation course. Area : Jade-Weser	(Half Group) Theme : Seawatch (Exercise Seawatch) - Passage Planning - Restricted visibility - Preparation of Passage Planning. Area: Zeebrugge
WEEK 10 08-12 MARCH 1993	WEEK 13 29-02 APRIL 1993
(Full Group) Theme : Go to anchoring (Day-night) - Preparation - Manoeuvring principle Exercise : Steering Simland 1 Day 1 Night Area : Simland-Cuxhaven	(Half Group) Theme : Short Passage (River-Sea-River) (1. Failure Management) - Preparation - Manoeuvring - Alternative actions Exercise : Elbe-Weser Area : Deutsute-Bucht
WEEK 11 15-19 MARCH 1993	WEEK 14 05-09 APRIL 1993
(Full Group) Theme : Seawatch (Exercise Seawatch 2) - Preparation - Information gathering - Bridge instructions - Assistant captain Area : Simland-Cuxhaven	(Half Group) Theme : Steering/Departure (2. Failure Management) - Preparation - Manoeuvring - Alternative actions Exercise : Anchoring Simland from North. Area: Simland-Cuxhaven
WEEK 11 15-19 MARCH 1993	WEEK 14 05-09 APRIL 1993
(Full Group) Theme : Seawatch/communication - Preparation Passage with some traffic Exercise : Passage Simland, Into Elbe. Area : Deutsche Bucht	(Full Group) 1.5 hours Introduction to one-man bridge watchkeeping at night. Modern equipment.

APPENDIX IV (Continued)

SHIP OPERATION OFFICER COURSE (SOO/SB)

WEEK 15 12-16 APRIL 1993	WEEK 18 03-07 MAY 1993
(Half Group) Theme : Approach run, plan, lay off. (3.Failure management) - Preparation - Manoeuvring - Alternating actions Exercise : Simland from East Area : Simland-Cuxhaven	(Half Group) Theme : Search and Rescue - Planning - Coordination - Ship/Ship Communication Exercise : SAR (6921) Area : deutsche Bucht
WEEK 16 19-23 APRIL 1993	WEEK 19 10-14 MAY 1993
(Half Group) Theme : River passage - Advice - With Pilot. (4. Failure Management) - Preparation - Manoeuvring Exercise : Entering Cuxhaven Area : Deutche Lucht	(Half Group) Theme : Approaches - Poor visibility - Approaching Ylissinien - Pilot from North - Preparation - Manoeuvre Planning - Debriefing Area : Zeebrugge
WEEK 17 26-30 APRIL 1993	WEEK 20 17-21 MAY 1993
(Half Group) Theme : River Passage : Emergency Anchoring. (5. Failure Management) - Passage Planning - Ship-Shore Communication - Going to Anchor Approaches Exercise : Freiburg-Anchorage Area : Deusche Bucht	(Half Group) Theme : Entering/Leaving Restricted Waters Tug Handling Entering Zeebrugge with bulk carrier Area : Zeebrugge

APPENDIX V

AMC SHIPHANDLING SIMULATOR TRAINING COURSE FOR PILOTS

MODULE 1 : Simulator bridge and equipment familiarisation

MODULE 2 : Shiphandling characteristics. The application of manoeuvring data. Introduction to simulator VLCC and Bulk carrier models.
EXERCISE 1 - Deep water turning circles and crash stops (S36)
(VLCC,BULK)

MODULE 3 : Stopping of large vessels : alternative methods.
EXERCISE 2 - Some manoeuvres to stop VLCC. (S41)
(VLCC/BULK)

MODULE 4 : Introduction to Newcastle data base.
EXERCISE 3 - Entering/leaving by day and night (S2)
(CONT full)

MODULE 5 : Inwards passage in ballast.
EXERCISE 4 - Entering Newcastle Day (VLCC/BULK) (S3)
EXERCISE 5 - Entering Newcastle Night (VLCC/BULK) (S3)
Environmental effects varied to pilots advice.

MODULE 6 : Inwards passage :Loaded. (VLCC-half load at 19.6)*
EXERCISE 6 Entering Newcastle. Day (VLCC) (S32)
EXERCISE 7 - Entering Newcastle. Night (VLCC) (S32)
Environmental effects varied to pilots advice.
Shallow water effects as possible.

MODULE 7 : Outwards passage.
EXERCISE 8 - Departure Deep Water berth. (VLCC-half)* (S31)
EXERCISE 9 - Departure Deep water berth. (VLCC-half)* (S19)
EXERCISE 10- Departure No 4 Kooragang. (VLCC-half)* (S17)
EXERCISE 11- Departure No 4 Kooragang. (VLCC-half)* (S18)
Environmental effects varied to pilots advice.
Shallow water effects as possible.

MODULE 8 : Monitoring progress round a bend in restricted visibility.
EXERCISE 12- Inward/outward in Horseshoe bend. (S32)
Environmental effects to pilots advice. (VLCC-half/ballast)

MODULE 9 : Interaction.
EXERCISE 13- Meeting channel traffic. Ballast in/out. (S3)
EXERCISE 14- Meeting channel traffic. Loaded in/out (S17/18/19)

MODULE 10 Free run exercises: Own ship and conditions as selected by the pilots.

* a minimum tide height of 6.8 metres is necessary.

DAY	A.M 09-1230	P.M. 1330-1700	Evening 18-2100
MONDAY	Intro.	MODULE 1. MODULE 2	MODULE 3
TUESDAY	MODULE 4 MODULE 5	MODULE 5	MODULE 6
WEDNESDAY	MODULE 7	MODULE 7	FREE
THURSDAY	MODULE 8 MODULE 9	MODULE 10	MODULE 10
FRIDAY	MODULE 10	COURSE ENDS.	

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NOTES: The choice in own ship model has deliberately been restricted to the use of two large ships. Pilots are however free to use any of the models as they wish. The programme is best run with two pilots, alternating between duties as pilot and helm. No other staff need be on the bridge, unless requested. Exercises will of necessity be repeated for each particpant, unless waived. The course could be run for one pilot but would require the provision of a helmsman. This would reduce the length of the course to about 3 days. It would be expensive.

The following exercises in other play areas will be of interest to pilots.

ALTERNATINE EXERCISES.
Module 2: S37,S38,S39
Module 5: S8,S9,S14,S25(VLCC ballast),S28,S35.
Module 6: S12,S13,S22,S23,S26,S34
Module 7: S27,
Module 8: S35.
Module 9: S12,S13,S15,S16.

Emergency Procedures:E2,E3,E5,E7,E8,E11,E12.

APPENDIX VI

GENERAL DESCRIPTION OF THE PROPOSED SHIPHANDLING SIMULATOR FOR VIETNAM MARITIME UNIVERSITY

1. GENERAL

The simulator is to have the mimic bridge compartment and the visual screen in front, and enable the trainees to practice under the navigational conditions preprogrammed by the instructor.

The visual screen is to be of 120 degrees width and mounted at the front of the bridge compartment. The equipment in the bridge compartment such as bridge console and radar display is to be arranged as in actual ship as practicable as possible.

2. PRINCIPAL PARTICULAR OF MODEL SHIP

The five (5) types of mathematical model of the own ship are to be provided for the ship maneuvering simulator as follows:

Bulk carrier	:	App.	60,000 DWT
Container vessel	:	App.	30,000 DWT
General cargo vessel	:	App.	18,000 DWT
VLCC	:	App.	240,000 DWT
Ro/Ro ships	:	App.	3,000 DWT

3. TRAINING ITEM

Typical training items are to be as follows:

(1) Maneuvering for entering and leaving port

(a) Sailing outward from anchorage.

(b) Combination of sailing outward from anchorage, disembarking pilot, and proceeding on passage.

(c) Making landfall and entering harbor.

(d) Combination of making landfall, approaching pilot station, embarking pilot, and proceeding into harbor to anchorage under condition of day, night or foggy scene.

(2) Anti-collision maneuvering

Offshore hazard avoidance under condition of day, night or foggy scene.

(3) Route and narrow channel passage

Coastal navigation and hazard avoidance under condition of day, night or foggy scene.

(4) Emergency maneuvering

More complex exercises than the above mentioned item (2) with emergency procedures introduced.

5. FUNCTION OF EACH EQUIPMENT

5.1 General

The simulator is to consist of the following sub-systems which a be linked each other and operated systematically.

- Bridge control simulator with sound system and simplified navigational aids.

- Radar simulator

- Visual system

5.2 Bridge compartment

Following equipment assigned to the bridge compartment is to be arranged.

(1) Overhead instrument panel

Following instrument is to be fitted on the panel:

1 - Clock

1 - Propeller RPM indicator

1 - Turning rate indicator

1 - Rudder angle indicator

1 - Speed indicator

1 - Wind direction indicator

1 - Wind speed indicator

(2) Steering stand

Following instrument is to be fitted on the stand:

1 - Auto steering panel

1 - Steering repeater compass

1 - Rudder command indicator

1 - Steering mode selector

1 - Steering wheel

1 - Non follow-up steering lever

(3) Engine console

Following instrument is to be fitted on the console:

1 - Engine telegraph lever

1 - Alarm buzzer

1 - Buzzer cut switch

1 - Air horn switch

(4) Radar display

A 12" radar display without ARPA is to be installed in the bridge compartment and display the echoes of simulated targets and coastline.

In response to the own ship's movement within the selected playing area, coastline video image signals are to be generated in the coastline generator and the realistic radar video of the coastline is to be produced on the radar display.

(5) Communication unit

Simulated VHF communication and intercommunication unit are to be provided between the bridge compartment and the instructor's station.

(6) Repeater compass for maneuvering

A repeater compass is to indicate heading of the own ship.

(7) Echo sounder

An echo sounder is to be provided to obtain the sea bottom's data of the playing area.

(8) Navigational display

A navigational display is to be provided in the bridge compartment to obtain the own ship position.

5.3 Instructor's station

(1) Instructor's console

The instructor's console is to be located aft of the bridge compartment, so that the instructor can observe the bridge compartment and the visual screen.

The following controls and functions are to be available at the instructor's console.

(a) Selection of own ship type, including its characteristics

(b) Selection of target ships from registered ship

(c) Setting of environmental conditions including day, night, wind, tide current and visibility

(d) Control of target ships

(e) Indication of various parameter list

(f) System freeze

The instructor is to be able to freeze the system operation.

(2) Monitor TV

One (1) set of visual monitor TV is to be provided for displaying pictures of the visual system.

One (1) set of radar monitor TV is to be provided for displaying picture of the radar simulator.

5.4 Visual system

The visual scenery image is to be projected on the screen located at the front of the bridge compartment.

The video projector system including the screen is to be provided to project the sea scope scene superimposed with target ships, buoys, bow of own ship and etc.

The visual system is to display color scenes, representing day and night time with or without foggy conditions.

5.5 Sound system

The sound system is to be provided and simulate the sound of engine of own ship and horn issued from own ship and target ships. And these sounds are to be generated by four (4) sets of speakers which surround the bridge compartment.

5.6 Simulated performance

(1) General

(a) Exercise playing area

- Max. range : Not less than 30 NM x 30 NM
- Number of exercise playing area : 2 areas; Tokyo bay (Yokohama port) ; Singapore (Keppel harbor)

(b) Own ship characteristics

- Helm angle : 35° port to 35° starboard
- Speed setting : NAV. FULL
  FULL AHEAD
  HALF AHEAD
  SLOW AHEAD
  DEAD SLOW AHEAD
  STOP
  DEAD SLOW ASTERN
  SLOW ASTERN
  HALF ASTERN
  FULL ASTERN
  EM'CY ASTERN
- Maximum speed (pre-programmable) : 0 - 50 Kts in steps of 0.1 Kt depend on the own ship characteristics)

(c) Target ship characteristics

- Max. number of ships simulated : 6 (for radar)
- Max. number of targets including fixed target : 8 (for visual)

(d) Circumstance parameters

- Tide : 0 - 360°/0 - 9 Kts
- Sea clutter : Variable (3 - 4 NM, radar display only)
- Wind : 0 - 360°/0 - 60 Kts

(2) Radar simulator

Simulated phenomena	:	Sea clutter Precipitation clutter Receiver noise

(3) Visual system

(a) Max. number of target: (Target ships, buoys and islands)		8 (appeared at one time)
(b) Lights (Night condition)	:	Max. 12 lights/target
(c) Projection angle	:	Horizontal field view : 120° Vertical field view : 15°

SHIP MANEUVERING SIMULATOR

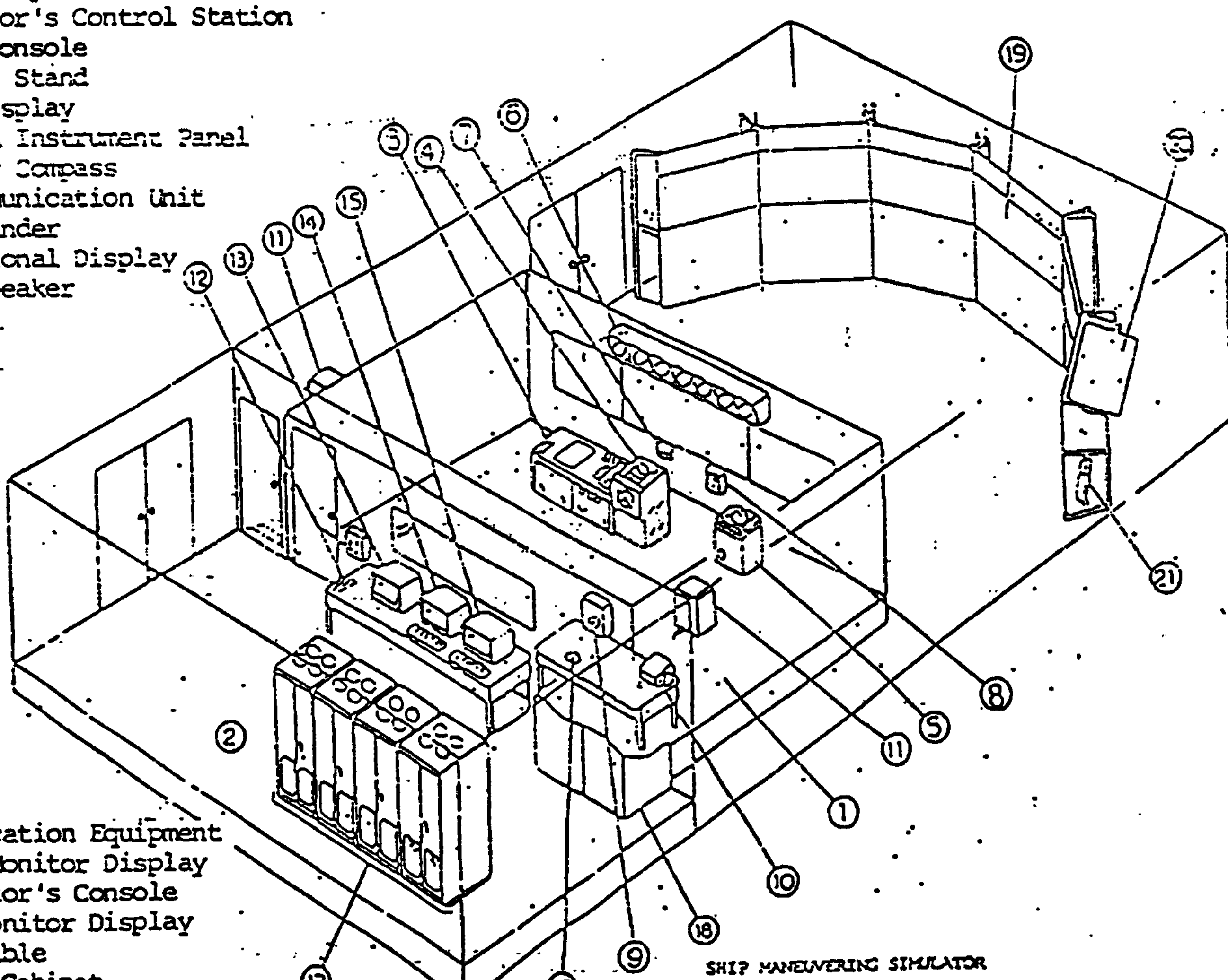
1. General:

   To enable training the maneuvering technique under the navigational conditions preprogrammed by the instructor by mimic bridge compartment and the visual screen.
   - Maneuvering for entering and leaving port
   - Anti-collision meneuvering
   - Route and narrow channel passage
   - Emergency maneuvering

2. Function of Simulation:
   - Projection angle to be 120° (horizontal)
   - Five (5) kinds of own ship type
   - Eight (8) target ships
   - Natural phenomeina of tide and wind
   - Noise of sea clutter, precipitation clutter and receiver noise
   - Sound generation system

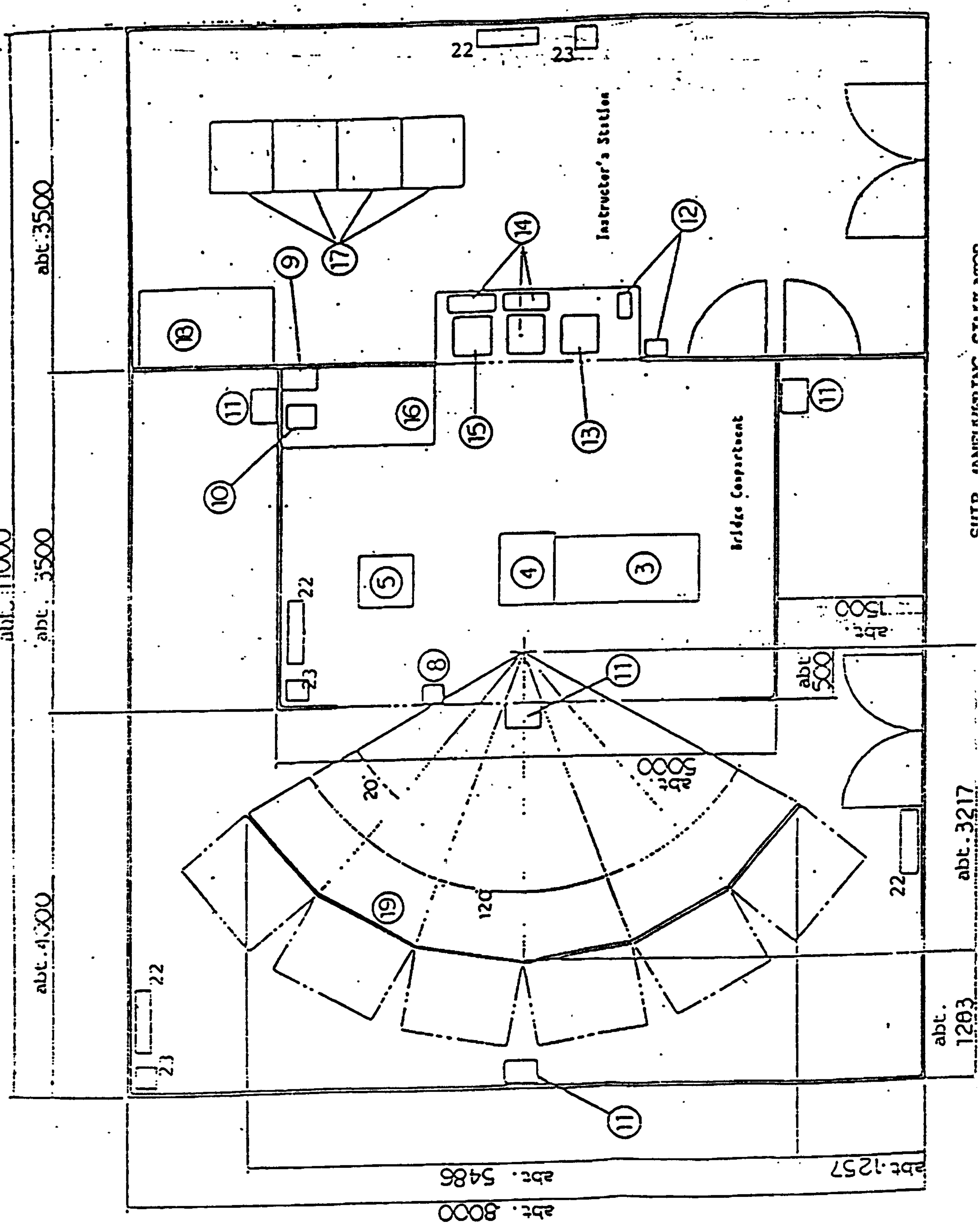
3. System Configuration:

1. Bridge Compartment
2. Instructor's Control Station
3. Engine Console
4. Steering Stand
5. Radar Display
6. Overhead Instrument Panel
7. Repeater Compass
8. VHF Communication Unit
9. Echo Sounder
10. Navigational Display
11. Sound Speaker



SHIP MANEUVERING SIMULATOR

12. Communication Equipment
13. Visual Monitor Display
14. Instructor's Console
15. Radar Monitor Display
16. Chart Table
17. Control Cabinet
18. CVCF
19. Visual Screen
20. Mirrir
21. Video Projector
22. Air Cooler
23. Air Drier



Instructor's Station
Bridge Compartment
abt. 11000
abt. 3500
abt. 3500
abt. 4000
abt. 8000
abt. 5486
abt. 1257
abt. 3217
abt. 1283
abt. 500
abt. 1500
abt. 5000
120
20
22
23