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The use of a shiphandling simulator to complement practical training at the Saudi Border Guard Naval Institute [SBGNI]

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THE USE OF A SHIPHANDLING SIMULATOR TO COMPLEMENT PRACTICAL TRAINING AT THE SAUDI BORDER GUARD NAVAL INSTITUTE

BY

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DECLARATION

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

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

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ABSTRACT

The dissertation introduces the use of a shiphandling simulator to complement the theoretical training of students at the Saudi Border Guard Naval Institute. A review of the requirements of the 1995 STCW Convention in regard to the use of simulators for training and assessment and the implementation of a quality standard system is undertaken.

The training of students and also of experienced mariners is a task for which simulators have become an increasingly valuable tool. The use of simulators for training purposes is especially important for MET institutions in which the practical training of students on board training ships is decreasing and in those areas in which the use of real vessels for training shows a risk to the mariner, to the vessel, to property and to the environment. The background to the development and use of simulators is considered at length and the possibility of having simulators for both training and assessment of performance at the Institute is discussed.

One of the conclusions is that trainees at the Institute can be trained in manoeuvring conditions that would take many years to encounter in real life, and that due to the modernisation of the fleet, the experienced mariner can benefit from this type of training when required to transfer to ships of different size, type, propulsion, manoeuvring systems and modern navigational equipment.

The dissertation concludes that a change is appropriate, if the SBGNI wants to modernise the programs and curriculum and that the actual theoretical training does not guarantee the ability to perform. This would be the role of simulation, to produce practical situations so that trainees could gain experience under controlled and repeatable conditions.

TABLE OF CONTENTS

CHAPTER 4

Potential Use of Simulators at the Saudi Border Guard Naval Institute

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ARPA	Automatic Radar Plotting Aid
IMO	International Maritime Organization
IMSF	International Marine Simulation Forum
IMLA	International Maritime Lecturers Association
MET	Maritime Education and Training
SBG	Saudi Border Guard
SBGNI	Saudi Border Guard Naval Institute
STCW 1978	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978
STCW 1995	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1995

INTRODUCTION

The development and improvement of Saudi Boarder Guard operations requires continuous training of navigation and engineering personnel. In 1973, the General Command of the Saudi Border Guard established the Saudi Border Guard Naval Institute (SBGNI) in Jeddha, primarily to train ratings for the operation and maintenance of its marine units and to develop new navigational and technical-engineering skills through the implementation of advanced courses.

Since its beginning, the SBGNI implemented a traditional method of teaching, combining classroom teaching, workshop practices and sea time on board boats and whenever possible in the T/S TEBUK.

The methods employed at the Institute have proven insufficient to cope with the changes experienced by naval fleets since the foundation of the SBGNI, twenty-three years ago. New teaching approaches and skill acquisition methods are needed. The introduction of a new generation of advanced vessels and equipment into the SBG fleets requires the updating of curriculum, equipment, teaching tools, etc. if the SBGNI wishes to graduate seamen with competence according to the changes in the maritime and naval fields.

The aim of this dissertation is to review the latest on the training of seafarers, teaching and skill acquisition methods, the tools developed and available at an international level, in order to find a method that can improve skill acquisition at the SBGNI.

The dissertation is divided into five chapters and à summary and conclusion. Chapter One reviews the objectives of the SBGNI, its current teaching situation and equipment, the workload by specialisation and method of assessment. Particular emphasis is placed on the need for practical teaching tools to develop skills in new cadets and improve and maintain skills through refresher courses for in-service personnel.

Chapter 2 is dedicated to the examination of the STCW 95 and the impact that this international convention will have in MET systems around the world. It considers the training of seafarers, required by the Convention, the relevant regulations on the introduction of marine simulators as teaching and assessment tools, the improvement and emplacement of quality standard systems at all levels of the maritime administration.

With the entry into force of the STCW 95 Convention, in February 1997, MET institutions will have to update their curriculum in order to accommodate the standards for training of the Convention. Emphasis is made on regulations concerning the use of simulators as a means of achieving the international standards

The author is fully aware of the limitations in regard to the application of the Convention to naval vessels. Article III of the STCW95 tacitly excludes seafarers on board vessels with the characteristics of the SBG's fleet. However, the same Article states that the State shall ensure that seamen serving on board these kinds of vessels meet the requirements of the Convention.

Around the world, the training of marine personnel has followed the rapid developments in ship operations, ship building, safety and pollution prevention requirements, thanks to the efforts of the International Maritime Organisation (IMO). Educational and training requirements for officers, ratings and maritime personnel in general have also changed accordingly. Probably, the most significant changes have been in the areas of ship instrumentation and seamen's competence.

Consideration is given to the use of marine simulators as training and assessment tools. It considers the use of shiphandling simulators as complementary practical training for cadets and refresher courses at the SBGNI. It addresses the problem of modernising the nautical teaching program of the SBGNI by considering the adoption of the regulations of the Convention.

The chapter also considers the role and experience required from instructors, assessors, and simulator staff according to Regulation I/6 and Section A-I/6 of the STCW 95 Code.

Chapter 3 builds the background of the marine simulator. These computer driven devices are seen as the way to bridge practice and the mainly theoretical education offered at the Institute. A simulator represents the real operational situation on board ship and the means to control that situation. It gives practical experience of ship tasks, in a safe and effective way. Shiphandling simulators have been designed to train mariners, from an experienced pilot to the freshman of the naval schools. This simulation exposes trainees to a significant range of experiences in seamanship, shiphandling, emergencies and navigation in a short time.

Many types of marine simulators have been developed over the years to help tackle the problem of binding theory and practice. The Modelboard System, the Shadowgraph, the Slide Projection System, the Nocturnal Display, the Computer Generated Image are part of the evolution of the marine simulator. Today these devices are categorised in part-task, single task and full mission simulators.

Chapter 4 deals mainly with the first stage in the decision process to acquire a simulator. The chapter gives consideration to the various types of training contemplated in the Training Scheme of the SBG. It identifies the areas where all categories of simulators can have a significant role in the training activities of the SBGNI, given emphasis to a gradual implementation from single task and part task devices until a full mission solution can be implemented.

The introduction of the principles of objective training in MET is also considered. Some typical uses of simulators in organisations of military nature are explained.

Chapter 5 is dedicated to the experience that trend-setter MET institutions of different countries have in simulator training, as one of the ways that inexperienced schools could have for the implementation of their own solutions. The cases of Australia, the UK and Germany are considered. Other methods are mentioned such as the manufacturer's training programs, learning on the job, and the IMO model courses.

Finally, the author recognises that the implementation of the STCW 95 will not be exempted from problems. The institutionalisation of quality standard systems according to the provisions contained in Annex 1, Part A of the Code, Section A-I/8 and Annex 2, Part B, of the Code Section B-I /8 to the adoption of objective assessment and structural planning constitutes a real challenge.

The turn for consideration of the role of the human element in most accidents and incidents has arrived. The adoption and implementation of IMO's STCW 1995 is aimed at solving the problem by seeking the standardisation of the teaching methods using the most modern technology, made both mandatory and optional by the STCW 1995 Code.

In the area of skill acquisition, the STCW 95 opens the opportunity to use simulators for the assessment of competence. The implementation of the Convention provides an excellent opportunity for the Institute to bring its curriculum and standards and most probably the syllabuses, in line with the international standards required and suggested by the Convention.

It has been fifteen years since the introduction of the PC. The growth in both power and applications is extraordinary; this together with the continuing cost reductions is having a profound impact on the way teaching is conducted and is also making a dramatic change in ship systems and operations onboard a ship.

This dissertation ends with a summary and conclusion with the hope that the coming generation of seafarers, trained at the Institute, will benefit from modern teaching technology.

CHAPTER 1

AN OVERVIEW OF CURRENT STANDARDS AT THE SAUDI BORDER GUARD NAVAL INSTITUTE

1.1 Introduction

The development of the Saudi Boarder Guard (SBG) has demanded the training of nautical personnel to man the patrol and other category of boats. In 1973 the General Command established the Saudi Border Guard Naval Institute (SBGNI) in Jeddah, primarily to train ratings and allow the career development of junior officers that the force requires.

The Saudi Boarder Guard Naval Institute (SBGNI) was entrusted with the task of training the SBG's personnel. The following are the main objectives of the Institute:

1. To train new cadets and develop navigational skills for in-service crews through the implementation of navigation and refresher courses.
2. To train cadets of different backgrounds in a variety of technical skills required by the marine departments and maintenance workshops.
3. To train the engineering and maintenance teams necessary to run and maintain onboard operations.

The Institute is responsible for providing the appropriate training for cadets, required for the operation and maintenance of its marine units and naval bases. Since its foundation the SBGNI has graduated over 3 000 ratings in more than 30 technical subjects.

From the beginning, the Institute chose a traditional method of training cadets in navigation, shiphandling and engineering subjects by combining classroom teaching, workshop practice and sea time on board small boats and whenever possible in a dedicated training ship, the T/S TEBUK. The SBGNI has trained cadets using some of the teaching facilities shown in Table 1.1, and complemented, with increasing difficulties, with training at sea.

Table 1.1 Teaching Facilities and Aids at the Institute

Method	**Facilities**	**Teaching Aids**
Theoretical	Classroom	Blackboard, projectors laboratories
Sea training	Small Boats	Magnetic compass, chart/ plotting equipment, echo sounder, radiotelephone
	Dedicated Training Ship ... (T/S Tebuk)	Navigation equipment Communication equipment.

From the table it is easy to note that since its beginning the Institute had no difficulty in choosing the teaching methods and the teaching aids to be employed in the training of its cadets. With time though, technological advances in almost all areas of shipping and navigation around the world have updated most of the equipment, teaching aids, vessels, etc. and to a greater extent even the teaching methods. The Institute must follow these trends if it wants to continue training competent personnel.

Of special interest in this dissertation is the actual conditions of the training vessels. Natural deterioration, escalation of running costs, provision of spare parts for vessels with an age of 20 years or more, make practical sea-training for cadets and navigation refresher courses for officers and ratings less frequent and increasingly difficult.

For cadet training the SBGNI complements classroom instructions with practice on board the T/S TEBUK. This training ship has the following details: length 60m, breadth 10m, draft 2.50m and displacement 585 tonnes (Appendix A, Fig. A1).

Needless to say, this is the only time when students have the opportunity to practice with the instrumentation and equipment on board a ship (see Table 1.2). In the opinion of the author, if this opportunity ceases to exist, due to the problems mentioned above, the training will be reduced to only theory, which obviously would be inadequate, to say the least, according to today's standards.

Table 1.2 T/S TEBUK Main Training Equipment

1. Mx 1105/1157 GPS
2. Loran Convention North Star 800X
3. Loran Convention FRUNO
4. MNS 2000
5. Radar - Racal Decca 2690 BT series (with ARPA facility)
6. Radar - Racal Decca bridge master
7. Gyro Convention. Plaith (Navigat II)
8. D.F. Marconi Marine Lodestar IIID
9. VHF Debec
10. VHF Marconi Marine Nautilus-D
11. Echo sounder - Echometer ELAC
12. Echo sounder - simrad EN
13. Speed log
    Doppler Speed log
    Sperry marine - SRD - 331

The methods described above have also proven to be insufficient to train the deck personnel that the organization needs. New teaching and skills acquisition methods are necessary due to the technological advances the nautical fleet is experiencing. This dissertation concentrates on finding new and modern methods to train cadets of the SBGNI. Fortunately, this is the time to address this question, as IMO's STCW 78 Convention has recently been revised. New teaching methods using the most modern technology are made both mandatory and optional in the STCW 1995 Code.

1.2 Training Courses for Officers and Ratings at the Saudi Boarder Guard Naval Institute

This section summarises the SBGNI's specialisation courses, particularly the nautical subjects. The aim is to show the total workload these courses represent in the overall time that the cadets spend in the Institute and the need for practical training.

The basic general training plan includes the following categories:

1. Courses for cadets in nine specialisation areas
2. Refresher courses for officers and ratings
3. Introductory courses for newly appointed junior officers
4. Compulsory refresher courses for in-service personnel

The specialisation courses are organised as follows:

A. Courses for Officers

A.1) Mechanical engineering

A.2) Electrical engineering

A.3) Electronics engineering

A.4) Advanced navigation course

A.5) Supply and administration

B. Compulsory and refresher courses for officers and ratings

C.1) Nautical Officers refresher course

C.2) Power electric operation and maintenance

C.3) Electronics operation and maintenance

C.4) Deck Nautical Petty Officer

C.5) Nautical Petty Officer navigation

C.6) Nautical Petty Officer radio operator

C.7) Nautical Petty Officer rescue

C.8) Nautical Petty Officer welding

C.9) Nautical Petty Officer supply

The courses for officers are a part of the requirements for advancement in the officer's career in the SBG. Courses also serve as an introduction to the SBG for all officers, specially for officers graduated from academies abroad. The courses serve as an introduction to the specific job and familiarisation with the operations of the SBG.

The specific goals of the Institute are summarised below.

1. To maintain the technical level of the SB Guard officer
2. To develop skills in their field of specialisation
3. To impart new technical knowledge in their field of specialisation
4. To qualify officers for new appointments in technical fields
5. To offer general and mandatory courses, such as fire fighting, damage control and English.

Officers take part in the category of nautical refresher courses for all types of specialisation, nautical specialised courses for each specialisation, watch keeping courses and advanced specialisation courses.

As shown in Appendix A, Table A1 nautical courses for officers represent 22.4 percent of the total workload of the Institute. To the nautical officer the general courses offered are basic mechanical engineering, basic electrical engineering and aids to navigation electronics. Specialised subjects are firefighting and damage control, rules of the road, ship handling, communications, celestial navigation and coastal navigation.

The assessment method for officers' performance is based on a system of one thousand marks. Seven hundred marks are assigned to practical training.

1.3 Specialisation Courses for Petty Officers (Ratings)

Courses for ratings are divided into the following categories:

- General instruction subjects (mostly compulsory subjects).
- Navigation
- Ship operations
- Marine control and engineering courses
- Electrical and electronics engineering and machinery
- Ship maintenance
- Communications
- Special training courses (diving, etc.)
- Administration and managerial courses

The training objectives for each rating specialisation are given in the Table 1.3. Appendix A, Table A2 shows the total time assigned to the categories and the specific weight within each category. Nearly 42 percent of the total time is spent on general subjects, 18 percent is dedicated to navigation subjects, 19 percent is allocated to technical courses, six percent to ship maintenance courses, five percent to courses of administrative and managerial nature.

Table 1.3 Training Objectives for each Specialisation Course

1. Operation and Maintenance of diesel engines
   1.1 To qualify candidates to operate diesel engines and ship machinery
   1.2 To qualify candidates in maintenance of engines and machinery
   1.3 To qualify candidates to do maintenance in workshops.
2. Operation and maintenance of electrical equipment
   2.1 To qualify candidates to operate and use electrical equipment
   2.2 To qualify candidates to perform maintenance work on electrical equipment
   2.3 To qualify candidates to work in maintenance workshops.
3. Operation and maintenance of electronic equipment
   3.1. To qualify candidates to operate and use electronic equipment onboard ships
   3.2. To qualify candidates to perform minor maintenance on electronic equipment
   3.3. To qualify candidates to work in maintenance sections in nautical workshops.
4. Navigational equipment
   4.1. To qualify candidates to operate navigational equipment onboard ships
   4.2. To qualify candidates to carry out chart plotting and perform helmsman duties
   4.3. To train candidates to perform maintenance for naval vessels
5. Radio Operator
   5.1. To qualify candidates to operate, receive and transmit signals onboard ships
   5.2. To qualify candidates to perform minor maintenance on radio equipment.
6. Diver Petty Officer
   6.1. To qualify candidates for rescue and salvage operations
   6.2. To train candidates to inspect and clean ship hull and propellers
   6.3. To qualify candidates to perform maintenance work using diving equipment
7. Welding
   7.1. To qualify candidates to carry out the following duties:
      a) Metal welding using gas welding equipment.
      b) Metal welding using electrode welding equipment.
      c) To do maintenance routine work on welding equipment.
8. Supply
   8.1 To qualify candidates to carry out duties in nautical stores
   8.2 To carry out office and administrative duties in nautical units.
   8.3. To work in sea ports and to apply Saudi Boarder Guard rules

According to the objectives of this dissertation it is worth noting that only 7 percent of the total training time is allocated to practical ship navigation and operations. This percentage is a reflection of the limitations that the SBGNI has for cadets' practical training at sea.

The method for marking trainees is based on written and oral examinations. This method, in the opinion of the author, puts more weight on the acquisition of knowledge, but little weight is placed on the development of skills so as to allow the candidates to show they possess the know-how and understanding of the job. New teaching methods, due to new technological advances, and new assessment approaches are necessary in the Institute, if it aims to fulfil the SBG objectives for the years to come.

CHAPTER 2

IMPACT ON TRAINING OF THE STCW 95 AND THE USE OF SIMULATORS

2.1 Introduction

Chapter 1 of this dissertation presented the Saudi Border Guard Naval Institute (the Institute here onwards), organisation and curriculum. The present chapter looks at ways to improve the nautical program.

The improvement of the Institute's programmes needs to look at the latest technological developments in training. The simulator-based training has been now for some years a technological innovation in maritime training. With the implementation of the new STCW95 the Institute should take advantage of the regulations and guidance in respect of the use of simulators for training and assessment.

Article III of the STCW95, on application of the Convention tacitly excludes seafarers on board "... warships, naval auxiliary or other ships owned or operated by a State and engaged only in governmental non-commercial service ..." from the statutory clauses of the Convention.

However, the same article also states that " ... each Party shall ensure (...) that the persons serving on board such ships meet the requirements of the Convention so far as is reasonable and practicable."

So far, a person employed by the SBG is expected to work his entire working life in SBG units, and it is also true that resistance to change is high, when the introduction of new technologies is at stake. But everything in life is subjected to change. It would seem likely that officers of the SBG seeking certificates of competency would not wish to be disadvantaged in the marketplace by the lack of qualifications that the STCW95 requires and the SBG would be wise to make allowance for such demands, in addition to the basic radar training courses.

If this argument is not convincing enough, the SBG has more to gain than to lose by adopting, if not all, some of the standards stipulated in the STCW 1995. The experience of many experts, which is incorporated in those standards, should help to shape the SBGNI programs.

2.2 Simulators and the requirements of STCW 1995

It took a while for the international maritime community to recognise the fact that the use of simulators in training brings many training tasks closer to shipboard practice. The implementation of the STCW 1995 offers the opportunity to use simulators for assessment of competence as well as training and provides a good opportunity for the Institute to bring its curriculum and standards and most probably the syllabuses, in line with the international standards required and suggested by the Convention.

Critics of the simulation technology maintain that simulators are no substitute for real hands-on experience on the ship. The intention of the technology is to facilitate "hands-on" training in situations where it would be advantageous and where onboard training would be impractical. Training on board is indispensable, to the degree that after being trained on simulators the trainee must adapt this knowledge and skills to the particulars of the ship type and the feeling of reality.

While the use of objective learning has become a standard practice in MET programmes in many institutions around the world, the use of specific learning objectives is limited in those institutions where hands-on facilities are not available. In the latter case, training continues to be separated from much operational shipboard practices.

As stated in chapter 2, examination of the Institute's shipboard training program, the existence of a training ship (T/S Tebuk) is no guarantee for trainees to get the opportunity to acquire the necessary skills required on board, for many reasons. The fact is that trainee watchkeepers are not having the chance to practice what they have been taught at the theoretical level. Every day that passes, the gap between theory and practice gets larger in this way.

Another argument to justify the use of the modern teaching-learning technology is the overwhelming proof that seafarers have not always been able to use modern navigation technology without endangering safety at sea and the marine environment. Lack of training and over-confidence in technology have resulted in marine casualties. Terms such as "radar-assisted collision" and "computer-assisted collision" have been used in context. These terms imply that accidents have partly happened because of the use of radar or ARPA.

The main conclusion is that modern navigation equipment has to be operated by navigators who have a good understanding of the possibilities and limitations of the equipment. Seafaring personnel have to be trained in the use of modern navigation technology.

The new technology of simulator- based training provides an alternative for solving problems. In simulators the trainee can acquire the necessary operational skills, with no risk for himself, the ship, property or the environment.

After all, as Stammers et al (1975), cited in Muirhead and Zade (1994), has stated training is

> "The systematic development of the skill behaviour pattern required by an individual in order to perform adequately a given task or job."

By using simulators effectively, in a realistic way and with well trained instructors the transfer of knowledge and the development of skills is not only possible today, but it requires less time to develop, than the real solution. Examples of the latter can be found in the aviation and nuclear industries.

The availability of navigation simulators in MET institutions has accelerated in the last few years. (Appendix C). Radar and shiphandling simulators are the most wide spread. Recent technological developments have also resulted in the improvement of audio-visual effects, more realistic and close to the real thing. This technology is becoming more accessible and affordable with time, specially for operators of "blind" radar and navigation simulators. The growth of GMDSS simulators and PC based systems has increased the degree of acceptance of the technology.

Table 2.1 Number and Type of Nautical Simulator

	Number
Simulators with a visual ship handling capability	104
Radar and Radar Navigation	275
Navigation instruments	.60
GMDSS	50
High Speed Craft..	2

Source: Muirhead, P. (1996). 1st International Conference on Marine Simulation Towards Safer Seas and Cleaner Oceans, 23 -27 Feb.

In the training area, the STCW95 Convention pays attention to the problem of training of seafarers on modern equipment and places emphasis on skill acquisition and demonstration of ability to perform tasks. One of the main features of the revision is the adoption of STCW 1995 Code, to which many technical regulations have been transferred. Part A of the code is mandatory while Part B is recommended.

The modernisation of the curriculum and syllabuses of the Institute would depend on compliance with the following regulations, and related sections of the Convention and the relevant parts of the Code:

Annex to the Convention, Chapter I, Regulation I/12

Use of Simulators

Annex 1, Part A of the Code, Section A-I/12

Standards governing the use of simulators

Annex 2, Part B, of the Code Section B-I /12

Guidance regarding the use of simulators

Chapters II, III and IV and VII of the Code Part A

Standards of competence for deck, engineering and radio operators

Annex to the Convention, Chapter I, Regulation I/6

Training and assessment

Annex 1, Part A of the Code, Section A-I/6

Training and assessment

Annex 2, Part B, of the Code Section B-I /6

Guidance regarding training and assessment

Chapter VII of the Convention on Alternative certification

Annex 1, Part A of the Code, Section A-I/8

Quality standards

Annex 2, Part B, of the Code Section B-I /8

Guidance regarding quality standards

The requirements of the STCW95 Convention in regard to simulation-based training and quality standards will be described in the following sections.

2.3 Analysis of the Annex to the Convention, Chapter I, Regulation I/12 Use of simulators

The first aspect to notice in regard to Regulation I/12 on the use of simulators for training and assessment is that the Convention makes the use of Radar and ARPA simulators mandatory. Part A of the Code contains the performance standards for radar and ARPA simulation that all simulators must meet after 1 February 2002. Existing simulators or those brought into use before 2002 must also comply with the performance standards from 1 February 1997 unless exempted from full compliance by the party concerned. The same requirement also applies when a party wishes to use simulators for the assessment of competence or to demonstrate continued proficiency required by Part A of the Code.

2.3.1 Analysis of Annex 2, Part B, of the Code Section B-I /12 Guidance regarding the use of simulators

Regulation I/12 was drafted to leave the door open to further use of simulation technology in other areas as simulators became more readily available and accepted. Thus Part B-I/12 of the Code contains guidance on recommended performance standards for non-mandatory types of simulation equipment used for training and/or assessment of competence or demonstration of skills in five identifiable areas :

- navigation and watchkeeping
- ship handling and manoeuvring
- cargo handling and stowage
- radio communications and
- main and auxiliary machinery operation.

Performance Standards

These are regulated by the following provisions:

Annex to the Convention, Chapter I, Regulation I/12 Use of Simulators

"1. The performance standards and other provisions set forth in section A-1/12 and such other requirements as are prescribed in part A of the STCW Code for any certificate concerned shall be complied with in respect of:

.1 all mandatory simulator- based training;

.2 any assessment of competency required by part A of the STCW Code which is carried out by means of a simulator; and

.3 any demonstration, by means of a simulator, of continued proficiency required by part A of the STCW Code.

2. Simulators installed or brought into use prior to 1 February 2002 may be exempted from full compliance with the performance standards referred to in paragraph 1, at the discretion of the Party concerned."

Annex 1, Part A of the Code, Section A-I/12 Standards governing the use of simulators, Part 1 Performance standards, General performance standards for simulators used in training

This provision gives emphasis to the following aspects:

Each Party shall ensure that any simulator used for mandatory simulator-based training shall:

- be suitable for the selected objectives and tasks
- be capable of simulating the environment and equipment in relation to such
- provide an effective interface between trainee, environment, equipment and instructor or assessor
- permit an instructor or assessor to control, monitor and record exercises for the effective debriefing of trainees or effective assessment of a candidate's performance as appropriate

As stated by Muirhead (1996b), in the coming years, not only will MET institutions have to consider a simulator facility to meet course training objectives, but also use simulators for assessment of performance. The obligation is to see that instructors and assessors are properly trained, qualified and experienced for these roles.

2.4 Trainers and Assessors Qualifications

In all cases personnel using simulators for training or assessment have to be appropriately qualified and experienced. Regulation I/6 of the Convention and Section
A-I/6 of the Code on Training and assessment states that:

"Section A-I/6

Training and assessment

1 (...)

2 (...)

Qualifications of instructors, supervisors and assessors

3 Each Party shall ensure that instructors, supervisors and assessors are appropriately qualified for the particular types and levels of training or assessment of competence of seafarers either on board or ashore, as required under the Convention, in accordance with the provisions of this section."

2.5 Implementation of STCW 1995

Of course the implementation of the STCW 1995 represents challenges and problems that MET, in general and the Institute in particular, will have to face in introducing and implementing the provisions of the STCW 1995 and the STCW Code.

The first step in implementing the provisions of the STCW95 and related Code in regard, to simulation-based training should begin with the identification, definition and drafting of the quality standards system. The provisions are contained in Annex 1, Part A of the Code, Section A-I/8 Quality standards and Annex 2, Part B, of the Code Section B-I /8.

Some of the challenges that the SBGNI will face can be summarised as follows:

1. The implementation of the regulations of the STCW 95 Convention, and the the STCW Code.
2. The implementation of the national quality standard system for training, assessment, certification, endorsement and revalidation of seafarers' certificates of competence, following the STCW 95 requirements. The national system is still to be defined. The obligation is defined in Regulation I/8.

   Each Party shall ensure that:

   In accordance with the provisions of section A-1/8 of the STCW Code, all training, assessment of competence... are continuously monitored through a quality standards system to ensure achievement of defined objectives, including those concerning the qualifications and experience of instructors and assessors...
3. To implement the national standards for the administration of programmes, qualification and experience of instructors, assessors, advisors, as well as the equipment.
4. The adoption of a structural planning approach for MET training.
5. A system for internal monitoring training activities as to detect deficiencies and take appropriate corrective actions.
6. Produce an independent evaluation of institute training activities.
7. Present a report to the government as part of the IMO requirement on the results of the independent evaluation.

The process is going to be long and not free from problems along the way. Among the most pressing problems that the Institute has to face are:

- Attitudes and resistance to change
- Lack of expert personnel in quality standards and systems

A quality standards system requires a structural way of planning training programs and courses. These will require experienced instructors and the training of the existing staff.

- To train instructors and administrators to understand and adopt:
- A system to assure the qualification of instructors, trainers and administrative staff.
- A policy for the administrative, academic and support levels as well as standards of courses and also equipment.
- A method or technique for quality control (Planning -- operation -- evaluation -- correction -- planning, etc.) will have to be implemented.
- A systematic monitoring arrangement to detect whether the training objectives are achieved by all the parties.
- An internal periodical evaluation of the objectives and ensure that corrective mechanisms are in place and operative.
- To allow an independent evaluation of the training activities, administration, qualifications, institutional framework.

As well as this internal quality standards process for institutions, section A-1/8 requires each Party to ensure that an independent evaluation of the activities of each of their MET institutions is conducted at intervals not exceeding 5 years in order to verify that education and training objectives are being met. Under section B-1/8 dealing with Guidance Regarding Quality Standards, such independent evaluation will include amongst other things a description of simulation equipment. The purpose of such an evaluation is to provide an independent assessment of the effectiveness of the quality standards arrangements at all levels.

The second most important task to perform before or in parallel to the implementation of simulator-based training is the adoption of a structural planning mode to make sure each step taken will assure the attainment of the objectives.

2.6 Simulator-based training

Waters and Muirhead (1994) have listed the most important factors to include in an effective simulator based training system:

a. The development of specific training objectives
b. The selection of tasks relevant to the training purpose and operational skills needed onboard the type(s) of vessels concerned.
c. The effective briefing and debriefing of trainees
d. The provision of a suitable simulator operating environment for the selected objectives training tasks.

2.6.1 Validation

The purpose of training is to develop a level of skill acquisition that would allow the trainee to adequately perform relevant tasks. This requires a process of validation of the training program. This process relates to the measurement of result of training to ascertain whether the behavioural objectives specified in the program have been met.

The steps for the establishment of training validity have been described by Muirhead and Zade (1994) :

1. Establishment of specific training objectives and criteria
2. Establishment of an appropriate simulator environment
3. Information gathering (pre-planning, briefing, observation, data and

performance recording)

4. Performance measurement (pre/post tests, task monitoring, feedback, debriefing)
5. Analysis of the attainment of the goals and objectives.

The performance of trainees determines the validity of training based on the criteria established by the training program. The trainer must have a clear understanding of the trainee's role in the workplace in order to develop instructional objectives and related tasks. The resulting correlation between the real and the simulated worlds should be the highest possible for the results to be reliable.

This is important in considering using the simulator as a further step to measuring the competence of trainees, i.e. an ability to perform a particular function in a safe and effective manner.

2.7 Using Simulators for Assessment purposes

All training activities need a system to measure results. Everyone involved in the process needs assurances that :

- the transfer of learning has been achieved,
- the training has created the required effect on the trainee,
- the required level of competency has been achieved,
- adjustments or improvements to the course have been considered and
- instructors perform satisfactorily.

There are basically three types of assessment required in simulation, each for a different purpose :

1. Evaluation of learning

   This refers to obtaining facts, skills and attitudes from the training.

2. Behaviour evaluation

   This identifies changes in the behaviour of the trainee as a result of training.

3. Result evaluations

   This determines the actual results and performance of individuals and organisations.

When considering maritime simulator training the evaluation of behavioural changes as well as the evaluation of the results of the training on the organisation are both long term evaluations, whereby a statistical approach is appropriate.

2.7.1 Performance measurement

There are two evaluation methods for measuring simulator training learning results:

1. Norm-referenced

It compares trainees with each other rather than to specific defined objectives. The norm is the average of the performances of the session, day, course etc.

2. Criterion-referenced evaluation

It uses a pre-defined minimum criterion based on the training objectives against which the trainees performance is measured and compared.

The assessment of many bridge functions and tasks are measured using the second method (criterion-referenced). Simulators provide for such form of assessment knowledge and skills and for their transfer to shipboard practice because they enable MET institutions to offer close-to-reality training for important and potentially dangerous tasks without any physical effect on the "ship", property, the environment and trainees.

The existence of assessment based on criterion-referencing assists the validation of any performance. The difficulty in the formulation of a competence performance standard is its mainly qualitative nature. Exact measurement is difficult in shiphandling tasks.

When evaluating individual competence, performance criteria must be established on an objective basis. Some qualitative comparison against real operations is necessary if confidence in the transfer of skills is to be achieved.

The prime criterion is that the candidate demonstrates the ability to carry out a task safely and effectively to the satisfaction of the assessor.

Part A of the STCW 1995 Code provides assessors with a comprehensive list of assessment procedures they have to follow. The trainee must know what the performance criteria is and be clearly briefed on the tasks and or skills by which their competency is to be determined. Assessors must ensure that assessment criteria have been selected with optimum objective measurement, keeping subjective judgements to a minimum.

There are some pre-conditions that make possible the measurement of skill acquisition on simulators:

1. The criteria for training and performance measurement must be clearly specified,
2. An appropriate operating environment for simulation activities,
3. The instructor or assessor must be properly trained and provided with effective recording and monitoring equipment, and
4. The tasks selected must relate to real ship operations.

Maritime administrations and MET institutions are responsible, under the Convention to ensure that the necessary steps to meet such pre-conditions have been taken.

2.8 Instructor and Assessor standards

A further important factor in effective training concerns the role of the instructor. Many years ago a series of experiments conducted in the USA concluded that:

> The instructor has a greater impact on the effectiveness of deck officer simulator based training than any of the specific simulator characteristics investigated. Hence the training device should directly address and assist the instructor in conducting training.
>
> Hammel, (1981) cited by Waters and Muirhead (1994)

The importance of ensuring that proper briefing, monitoring and de-briefing techniques are used by the instructor must not be overlooked. The instructor wields considerable influence upon the factors that enhance the learning rate of the trainee. The exercise parameters must be clearly specified and task objectives adhered to. This prevents the introduction of any extraneous variables by the instructor that might influence the task or performance beyond that conceived by the original training objective. Thus the training of simulator instructors assumes some importance.

For the first time in the Convention, mention is made of the qualifications and experience of instructors and assessors. Regulation I/6 requires parties to ensure that simulator staff are appropriately qualified for the type and level of training or assessment involved. Section A-I/6 of the Code is more specific in relation to simulator training and assessment as follows:

4 Any person conducting in-service training of a seafarer ....shall:

.3 if conducting training using a simulator:

.3.1 have received appropriate guidance in instructional techniques involving the use of simulators, and

.3.2 have gained practical operational experience on the particular type of simulator being used.

6

.5 if conducting assessment involving the use of simulators, have gained practical experience on the particular type of simulator under the supervision and to the satisfaction of an experienced assessor.

2.9 Installation of new simulation facilities

As Muirhead (1996) has pointed out, there are three elements to be taken into consideration when faced with the installation of new facilities:

1. Guidance in instructional techniques
2. Practical simulator operational experience and
3. Practical assessment experience on the simulator

The MET institution installing the facility, but not having the expertise has a number of options :

a. Short and intensive courses directed especially to instructors. The emphasis is in rather technical than in pedagogical aspects. These courses are part of the manufacturer's training programmes.

b. Another alternative is on-the-job training courses. With this alternative an experienced staff member is needed to ensure the validity of the training outcomes and the appropriateness of the techniques acquired.

c. Maybe the best approach to the required transfer of technology is to **study another institution's experiences in simulator training and operations**: This is regarded as the shortest way to acquire skills and operational knowledge. Members of organisations, such as IMLA and IMSF can be of assistance in making arrangements on an institution to institution basis. Many such institutions will provide training at little or no cost.

d. The STCW 1995 incorporates many of the **IMO model courses** by reference into the Code. It is recommended that new operators use these structured simulation programmes on a starter basis until they develop further experience. The main simulation programmes are:

1.09 Radar simulator

1.22 Shipsimulator and Bridge Teamwork

2.06 Cargo and ballast handling simulator

2.07 Engine room simulator

If instructors and assessors of new and experienced operators follow the guidance provided in the new STCW 1995 Code, they will be following in the footsteps of many experienced simulator operators who contributed through the STCW Sub-Committee to the development of the standards.

CHAPTER 3

THE GROWTH, DEVELOPMENT AND USE OF SHIPHANDLING SIMULATORS

3.1 Introduction

The use of simulators for training has been a feature of several industries for many years. To have a safe method to train pilots and avoid losses of costly equipment and trainee lives, the aviation industry has, over the years, developed excellent simulators.

This example and others in the nuclear industry and in the business community have been possible thanks to the advances in computer power integrated with the cost effective networking technology. Early in its development this technology was considered to have potential to transform instructional methodology and application of technology in naval and nautical institutions at all levels.

Advanced technology can offer a real promise in assisting nautical institutes in a broad based effort to significantly alter the teaching/learning relationship. Since the 1950s, radio, television, film and many other audio-visual aids have played roles in the instruction process. More recently, computing has been used more and more as an aid in the instructional process.

New technology has been introduced over the past two decades by many manufacturers in the area of ship automation and instrumentation. Microprocessors and software technology are now used in automatic radar plotting aids (ARPA), radar systems, electronic chart display and information systems, position-fixing systems, autopilot and other bridge systems, and communications between subsystems have been improved through the use of standard computer networks.

There are many challenges in seeking effective instruction through computer integrated instruction, including the need to adapt to rapidly changing computer hardware and software. Computer integrated instruction can be defined as instruction that uses computing technology as a development or delivery medium and can also integrate simulation.

The present chapter makes a review of the development of the marine simulator, from its beginning until the sophisticated computer systems linked with effective computer networks of today.

3.2 Background

The era of the automated ship began in 1961. Computers onboard ships were introduced in 1966, mostly of the analogue and electro-mechanical type. The first efforts to duplicate the behaviour of a ship under control conditions in the marine field dated back to 1968. The first ship's bridge simulation appeared in Göteborg, Sweden and the Netherlands (Muirhead, 1995). The SSES at Göteborg was initially designed for research work. It opened in 1967 using CGI to produce a mainly nocturnal picture on seven black and white CRT receivers (computer screens). Mounted in the windows of a bridge, the screens provided a 70 degree field of view, showing the bow, horizon line, buoys, ranges and lights. Own-ships range from an 8 000 tonne ferry up to a 350 000 tonne tanker; the main exercise areas were Europort, Brofjorden, Torshamnen and Göteborg.

The first microprocessors capable of being used in small computers were launched in 1971 by the Intel Corporation. This technology was promptly used in training in

1973. In that year training was concentrated on the interpretation and practical experience of ship behaviour in manoeuvres at sea, and in approaching and entering a port. The environmental effects were limited to wind and current only.

The past 30 years have seen great advances in many areas of technology used in naval and merchant vessels. The bridge of ships have undergone revolutionary changes. They have experienced the introduction of many new sources of navigational and environmental data. As Denham (1991) points out the process of correlating and interpreting all of the information was very labour-intensive, subject to human error at many stages of the process. In response to this challenge the new microcomputer technology was introduced for distributing, displaying, correlating, and logging shipboard data. This equipment automated most of the low level, routeing tasks involved in navigating a vessel at sea, significantly reducing the stress and workload of bridge personnel. This gave the crew on the bridge more time for doing the job that so far they do better than machines i.e., making decisions.

Computers are the machines that have changed the world. It has been fifteen years since the introduction of the PC by the IBM Corporation. The growth in both the power and applications of the PC and continuing cost reductions have changed the way business is conducted and is making a dramatic change in ship systems and operations onboard a ship.

As stated by Paetow, (1991) ship of the future concepts and several recent automated ships have elevated the traditional ship bridge to the "Ship Operational Centre" (SOC). The SOC operates as the main control centre that provides reduce manning and efficient operation of the vessel. The potential utilisation of computers in performing the function of the SOC requires the following subsystems:

1. Bridge/Navigation System
2. Ship Machinery Instrumentation, Monitoring/Control System

3. Cargo System
4. Management/ Administrative/ Communications/ Safety System

One of the main motivations for bridge integration and automation is the information explosion in navigation technology that has taken place over the past two decades. Besides the traditional gyroscopic and magnetic compasses, Doppler and electromagnetic speed logs, there are now a variety of radio and satellite navigators to be dealt with, inertial navigation systems, etc., all with their own peculiarities and characteristics.

In addition to the operational problems associated with increased system complexity, there are practical and also economic incentives for increased integration and automation. One factor is also the desire to reduce installation and maintenance costs by simplifying and reducing interconnections.

The most important functional capabilities of electronically integrated and automated bridges which are not available in traditional bridge designs are:

1. Automatic Data Collection (the navigation computer) and Distribution (the marine network)

The capability to collect and distribute data from navigation and environmental sensors automatically is the foundation upon which all other integrated bridge capabilities are built. Usually the most important type of sensor data on a ship's bridge is navigational information:

- - geographic position from a variety of position sensing equipment such as:
    - GPS (Global Positioning System)
    - Loran-C, Decca, Satellite Navigation System, Omega, etc.
- - Heading from the gyrocompass, the radar,
- - The gyropilot
- - Speed from the speed log, the radar or the position sensors.

In the integrated bridges it may be sufficient to bring all of this data to one central collection point (a navigation computer). The bridge system requires a means of distributing all of the data to all of the equipment which uses it. This requirement has led to the development of marine data distribution networks.

2. Graphical Data Display/Electronic Chart

The thousands of words of data received from all of the navigation sensors can easily be summarised in one's own ship moving on a chart, which depicts all local obstructions, both fixed and moving. This is called an electronic chart.

3. Automatic Data Logging

The integrated bridge system can automatically log information such, as position, heading, speed, wind speed and direction, navigation mode, and time. Data log files may be automatically sent via a satellite communicator to the home office.

4. Voyage Planning and Monitoring

Computers can simplify many of the computational details of voyage planning; for example computing track headings, ETAs to way points and Great Cycle routes. The track of an electronically recorded plan may be automatically overlaid on an electronic chart to show the planned route.

Although all of the functionality described above has been technically possible for several decades, a few key technologies have matured only over the past few years which makes the installation of that functionality on virtually any commercial vessel economically feasible. These newly matured technologies are described and listed as follows:

- Accurate Navigation Receivers/Global Positioning System (GPS)
- Affordable and Powerful Computer Hardware
- Touchscreen oriented Operator Interfaces
- High Resolution Graphics

5. Key Components for the Integration and Automation of Bridges

The components which make higher level bridge automation possible are links to the existing navigation equipment; they do not generally serve any independent role. They serve as a glue function for building higher-order structures out of already capable and sophisticated components.

The equipment described above makes use of the computer hardware technologies. Much of the software is shared by the operating systems, their file systems, their network, their I/O systems and their peripheral components.

3.3 Use of simulators as Training Devices

Ship simulators have been developed, built and used for many years in different industries, universities and institutes all over the world.

Today, a simulator-trained pilot can go directly from the simulator to the aircraft and perform as well as those pilots trained in the real aeroplane. The difference being in that the one trained in the simulator has spent less time in training, the number of special and emergency situations practised is greater and there has been a decrease in loss of life during training. Simulation in this industry is already an established science. Similarly, the nuclear industry, due to its very special characteristics and inherent dangers, relies on the use of simulators for scientific research and training of technicians.

The first motivation for using simulation in the maritime field was not training, but for research into ship design. Training systems and devices needed to be developed to provide proper training and utilisation of onboard systems.

Ship simulators (bridge/shiphandling) have been developed, built and used for almost thirty years in different institutes and colleges all over the world. The principle for all is almost the same. They have computerised mathematical simulation model programs describing the ship's characteristics, and consist of a bridge with controls and instruments partially or totally displayed around the wheelhouse, a central computer controlling the instrument and the visual display system.

Although the mathematical models in different simulators are not the same, all include ship dynamics and most of them calculate bank and shallow water effects. Rapid advances in simulation design have been made possible by the availability of microcomputer networks. One of the earliest computers using the concept of linked microcomputer networks for ship simulation was the Maritime Dynamics Corporation's microsimulator based on a BBC 8 bit micro-computer ACORN , with 32Kbyte RAM. With this equipment it was possible to get an elementary day scene, night scene, a radar picture and a model instrument screen.

Later machines built around 1984 used multiple machines, linked together by RS-232, Econet and Ethernet. The use of networks greatly increased the amount of computer power available, so that the limitations on computing power were those imposed by the market place rather than by the technology. Today a typical installation may consist of 80486s or a Pentium PC with 200 Mhz processor, 32 or 64 MByte RAM memory and over one Gigabyte hard disk, a minimum of 8 own ships and over 24 microcomputers linked by an Ethernet network utilising TCP/IP protocol for the interchange of information.

The microcomputer network based simulator provides the tool to create real Ship Operational Centre Training Systems. These systems today provide training to meet the requirements for the new generation of high technology ships. These systems have the capability to function as onboard embedded training systems and decision support systems. Embedded training systems are in use in sophisticated military systems.

3.4 Types of Simulators

There are some differences between marine simulators such as layout, wheelhouse instruments and control panels, as in real ships, but these are not the main differences which make them distinguishable from each other.

The main differences are in visual display systems. They all display the ship environment on the screen outside of the wheelhouse with a certain horizontal and vertical field of view normally between, 120 and 360 degrees. The visual display systems vary in technique, ranging from discrete slide pictures to sophisticated computer generated images (CGI).

A description of the main projection systems and technologies developed over the years follows:

-Model board system

-The shadowgraph

-Slide protection system

-Nocturnal display

-Computer Generated Image (C.G.I) visual display

3.4.1 Modelboard System

This was one of the pioneering systems in marine simulation. In this method the exercise area was constructed physically on a small scale. A small camera represents the ship in the exercise area, and is controlled, in scale, by orders from equipment and installation on the wheelhouse. The pictures from the camera or cameras are projected to a screen outside and around the wheelhouse. Target ships are represented by small model ships set to a fixed course and speed.

This system has a number of advantages, but there are some disadvantages that should be mentioned here. One disadvantage is that multiship exercise situations are difficult to generate on the screen. Another disadvantage is that it is difficult to create meeting situations with more than one target ship. The exercise areas are difficult and costly to make and to expand the library of model areas it is necessary to make a new exercise area model board. It takes considerable time to change exercise areas as it is labour intensive.

Several institutes have installed this kind of simulator. In 1976, TNO-DELFT in the Netherlands installed a single modelboard/pointlight source simulator originally for research purposes. It was able to display 120 degrees field of view. It could manage ships up to 545,000 d.w.t of different classes. Delft was able to operate the ship with wind, current and shallow water effect. The exercise areas consisted of open sea, coastal situation, harbour situation, single buoy mooring system and the inland sea. A special area was developed to allow for night visibility conditions. One disadvantage was that it could display only black and white vision.

A few years later an installation of a model board simulator was made at La Guardia Marine, New York, with the specific aim of training seafarers. It displayed a 150 degrees black and white horizontal arc of view plus 40 degrees stern view provided by a television camera as it moved over the exercise area. It had an advantage that side and stern views could be seen in the forward screen by rotation. It could operate an own ship of up to 250,000 d.w.t with 10 choices including tankers, bulkers, LNG carriers and even a navy frigate and tugs.

In comparison to DELFT, it had a more advanced technology and it was possible to provide controllable pitch, single or twin screw propellers, and bow and stern thruster configuration. In addition to bank and shallow water effects, tide and variable currents and different states of wind could be produced.

The other new features were vibration and sound of engines, use of up to 12 pull/push tugs and three anchors at the same time. More exercise areas and more traffic ships were included.

3.4.2 The Shadowgraph (1968)

In this method the visual environmental condition is displayed by using a point light source projection system, the shadow of cut out models of horizon and land mass objects are placed in front of the light source and projected onto a circular screen. The generated visual display is in colour and the background, navigational marks, moving water surface and clouds are visible. The constant view of the own ship forward of the bridge is produced on the screen by additional slide projectors. By using a point light source system it is possible to produce day-light, poor visibility and nocturnal conditions.

The movement of the model is achieved by a motion mechanism commanded by the computer. The motion mechanism has three degrees of freedom, X and Y movement, in horizontal plane, and rotational movement around the vertical axis Z in front of the projectors.

The Dutch Organisation for Applied Scientific Research (TNO), DELFT was one of the institutes which used this system. This one had a 120-degree field of view with day/night picture. They used nine simulated ships for the training courses which ranged from ULCC up to LNG carriers. The available exercise areas included open sea, coastal situation, harbour situation, single buoy mooring system and inland sea areas.

Almost at the same time MARIN also in the Netherlands used an identical system but with 360 degrees field of view, in black and white. With seven own ships available, one of the restrictions with this system is the high limitation of traffic ships.

3.4.3 Slide Projection System

In this system a large number of colour slides was taken from a scaled model of the exercise area (early development). These slides were displayed by computer controlled projector onto a screen producing the background. The sea, sky and navigational aids were produced by other projectors.

The German Academy of Nautical Sciences in Bremen installed such a system in 1975. That one covered an arc of display of 120 degrees. It was able to simulate the effect of wind and current forces plus shallow water effects; anchoring was also possible. It was programmed for two own ships, single and twin screw, and three target ships, at the first stage. The limitation of this simulator was its limited docking capacity, lack of visibility control and low flexibility with traffic ship scenarios. In 1979 Trondheim in Norway combined this system with nocturnal a spot light projection system. The nocturnal scene could display up to 12 target ships. It used 12 spot projectors for a 240-degree field of view. It was gradually upgraded.

In 1982 it had an improved projection system installed on a better screen, sea surface, bow wave and own ship forebody included. In 1985, improved new software was installed and a Solarton digital system replaced the analogue coastal generator. New ship design included a VLCC tanker, containership, cargo freighter, LPG carrier semi-submersible rig and supply vessel. Bank effect, shallow water and interaction effect could be simulated. Push/pull tug, berthing, mooring and manoeuvring within the port are available.

3.4.4 The Nocturnal Display

This is a simple, cheap simulation system suitable for training purposes. It is a night time visual system, which produces a series of light points from different light point projectors, each controlling the intensity, movement and colour of light points through computer control.

It was first made by the Decca Company for the Nautical College of Southampton, in 1977, it consists of 16 light point projectors each controlling the movement of light points. It projects a field of view of 100 degrees and manages up to four target ships. It is able to produce wind, current, shallow water effect as well as tug and engine vibration. A second unit was installed four years later which can be linked to the first one. Own ships included a VLCC in different conditions of loading, single and twin screw container ships, LNG, bulk and general cargo carriers. Later on, customs excise cutter and patrol craft were added.

Almost a year after the Decca company, V.F.W-FOKKER enhanced and improved the nocturnal display system for the Academy of Nautical Science in Bremen. The system uses 12 coloured light projectors for field of view of 315 degree, with two own ships and three target ships.

The same company produced a further upgrade of this type of simulation in 1981 with a computerised system controlling light points from 60 spot projectors to create a field of view of 360 degrees in a spherical screen. The bridge was fully equipped with all instruments and electronic navigational aids. An additional technique used a motion platform which permitted the bridge to roll up to 20 degrees either way, and to heave up to 45 centimetres in a full range of environmental effects up to sea state ten. Two years later the Norcontrol company, in conjunction with the Seagull company, provided a low cost and efficient nocturnal visual system using 24 spot light projectors. This was a very useful system to upgrade the present radar simulator to a visual simulator.

3.4.5 The Computer Generated Image (CGI) Visual Display

This is the latest system of visual display which has the ability to produce a large range of visual data. In C.G.I. the visual scene is produced and controlled digitally by computers. The exercise area and the environment with which the ship simulator interacts directly, is created numerically. The computer processes numerical data and creates a view of the environment around the ship as a continuous picture. Different conditions of daylight and night time can be generated easily including the effect of a range of visibility and weather conditions.

The Computer Aided Operation Research Facility (CAORF) was one of the first designs of this system. SPERRY designed and installed the first fully digitised ship simulation system in 1976. The visuals were in colour and had the ability to perform in day and night visual configuration with 240 degrees field of view controlling up to six target ships. With the aid of colour projectors it displayed the scene on to a cylindrical screen. It was originally designed only for deep sea conditions with simulated effect of wind forces and variable visibility. From initial work on this simulator it became apparent that the main area of research on training by simulator had to be done on enclosed and shallow waters. This demanded new features in the simulator.

In the next upgrade, bank effect, shallow water effect, interaction and current forces were included. Tug dynamics and anchoring capability as well as bearing pelorus and rate of turn gyro, were additional features that are now considered to be standard in new Simulators. In the latest upgrade they added bridge vibration with roll, pitch and heave visual motion and more fine and accurate display of sea texture and icefield and iceberg. The upgrade includes different traffic ship types, more tugs in push, pull and work in lashed mode, and up to about 40 own ship model configurations, as well as a library of exercise area data base.

It is interesting to know that after the introduction of this system, nearly all installed visual ship manoeuvring simulators have been of C.G.I. design.

There are a few problems with C.G.I. projection. One of them is the low luminous intensity at the screen, especially with front projection systems. Another problem is the smoothness of light movement across the screen, but with continuing development in technology these problems are rapidly being overcome.

3.5 Categories of simulators

3.5.1 Part and Single Task Simulators

Part-Task Simulators are invaluable in providing training to a large number of students in manipulative skills required by many bridge operational procedures. The add-on type of simulators to meet expanding needs make this alternative most attractive. The new state of the art equipment, including multimedia, virtual reality can be added and obsolete components eliminated without disrupting the operation of the main full-bridge simulator.

A tie-in capability via networking with the operation of the full bridge simulator can provide an opportunity for additional personnel to participate simultaneously in certain phases (e.g., radar piloting and collision avoidance) of a full bridge simulator scenario in progress.

3.5.2 Full Mission Simulators

It means a facility which is capable of reproducing a total bridge environment. In this category is included the shiphandling simulator. (Appendix A, Fig. A2)

This type of simulator has reached a high degree of complexity and sophistication. Full mission simulators are used to train small groups and team training.

The design of the bridge is perhaps the area of major interest in shiphandling simulators. The features incorporated in final designs of the bridge are determined by the different uses assigned to the simulator. This is achieved through a series of modules that allow the redesigning of several layouts according to the objectives of the training.

3.6 Use of Simulators as an Assessment Tool

Assessment, appraisal, evaluation, grading, measurement, testing, scoring, validating, all are terms used in the educational environment for something which is more or less related.

Assessment: the evaluation of a student's achievement.

Evaluation: the amount or value

Appraise: to assess the worth, value or quality

Grade: mark or rating indicating achievement or the worth of work done.

Scoring: establishing the result of a test or an exam.

Test: measurement device providing information about students.

Measurement: assignment of numerals to objects or events according to rules.

Validation: range of processes by which assessment can be examined to see how well training elements have worked in relation to the specific objectives.

In a few years marine training simulators have reached a great degree of sophistication. Cross (1993). However, the evaluation of maritime simulator training has not developed to the same level of sophistication as would have been expected.

In traditional training sessions the aspect of evaluation is relatively easy to cope with. The instructor can observe a trainee action, mentally compare this with an expected standard and give a score. In the case of simulator training complex systems have made this measurement difficult. In the opinion of the author there are two very distinctive, though complementary, attitudes to take into account when assessing or evaluating trainees' performance in simulator training:

First, simulator training is more than the relative performance of a trainee in a written examination. It is rather a set of behavioural processes, attitudes, skills development and knowledge that the trainee is prone to exhibit during a simulator training session.

Second, a computer based simulator is provided with sufficient working memory, which enables the instructor to save a great number of training situations and exercises. In addition to the play back possibilities, the instructor or the examiner can analyse the situations. This also allows performance comparisons between trainees, or between groups and training teams under the same set of inputs. With time a statistical tool to support the assessment tool should not be difficult to develop.

CHAPTER 4

POTENTIAL USE OF SIMULATORS AT THE SAUDI BORDER GUARD NAVAL INSTITUTE

4.1 The Border Guard Training Scheme

The Saudi Border Guard (SBG), like any other executive and operational branch of the Government requires constant training for its personnel, in order to give full compliance to the main functions and responsibilities stipulated by law and most importantly to face the everyday challenges proper to law enforcement and surveillance of the territorial waters.

It is in the functions of the SBG, defined in Article 3 of the Royal Ordinance on Boarder Security of 1975 that the basis for a training program for the SBG can be found. The main functions of the SBG are:

a. Security and control of border areas
b. Law enforcement in the territorial waters
c. Early warning mechanism
d. Search and rescue operations
e. Marine surveillance
f. Enforcement of fisheries regulations.
g. Security inspections of vessels in the territorial sea.
h. Police functions in the territorial waters
i. Casualty investigation

4.2. Organisation of the Saudi Border Guard

The Border Guard of the Kingdom of Saudi Arabia (SBG) was founded in 1353 H, (1934). The Royal Ordinance No. M/26 on Borders Security of 24 06 1394 H (1975

AD) and the Royal Ordinance No. M/27 on Ports and Marine Lighthouses of the same date created the Frontier Forces, and redefined and broadened the Border Guard functions. Resolution No. 1407 places the responsibility to make rules and regulations in the Ministry of the Interior. His Royal Highness the Minister of the Interior in turn delegates these responsibilities to the Director General of the Border Guard.

The Saudi Border Guard General Directorate is organised as follows: Department of Operations, Department of Marine Affairs, Department of Engineering, Department of Telecommunications, Department of General Service, Logistics, Budget and Financial Affairs, Legal Investigations, Administration, Contracts, and Supply.

The organisation requires a continuous training program at all levels. For this it has an extensive and varied training scheme which is met largely from its own budget. It achieves this by allocating resources to training and managing the resources through a system which integrates training with employment. The SBGNI is one part of the overall scheme.

This chapter deals mainly with the first stage in the decision process to acquire a simulator. It tries to identify the areas where simulators can have a significant role in the training activities of the SBGNI and it also serves as a pre-feasibility study on the procurement of simulators. The author is of the opinion that if the SBG desires to keep up with the pace of technological innovations in equipment and vessels, it should modernise its present training structure specially the means to achieve these new higher standards.

4.3 The Saudi Border Guard Naval Institute

The SBGNI was founded in 1973 as the direct result of the needs of the SBG for expansion. Its main goal is "training and qualifying Naval Frontier Forces personnel required for its ships and units" (Royal Ordinance No. M/26 of 24 06 1314H). For this the Institute carries out training programs for junior officers and ratings. The Institute also trains newly graduated officers from naval academies in the SBG operational procedures and law enforcement. In-service personnel from different departments of the SBG attend refresher and special courses at the Institute. Besides technical subjects, emphasis is placed on English as the language for reading manuals and instructions.

4.3.1 Objectives of the Institute

The SBGNI curriculum described in Chapter 2 of this dissertation is divided in the following levels:

A. Basic Training: to train ratings of diverse backgrounds in different nautical and technical skills required by the different departments and workshops of the SBG.
B. Continuing Education: to develop and train levels of skills in patrol boat crews
C. Special Courses: to train in-service units and teams in maintenance and repair.
D. Refresher courses as demanded by the departments and units
    a. Technical courses
    b. Maritime safety;
    c. Operational command;
    d. Law enforcement.

Although, it is a matter of opinion, some people place the services offered by the SBG on the civilian side, others place them on the military side. The fact is that both features are present in it. On the one hand SBG deals with the enforcement of civilian laws at sea. Its daily work deals with civilians. On the other hand the SBG has the military discipline and equipment that make people expect that it be prepared for contingencies of a military nature.

Any training emplacement created by a hybrid organisation such as the SBG must take into account the characteristics of the institution it serves (the client) and design their training activities accordingly. The SBGNI is the institution created by law to support the SBG training needs.

4.4 Initial Considerations on Implementing a Simulation Installation

In spite of the availability of hard, reliable and objective data on both effectiveness and value of simulation training the weight of subjective evidence and opinion is still very great.

The first consideration that SBG's decision makers should take into account is of economical and technical nature. From the economical point of view the criteria to use is obtaining the best value for money. This is achieved using the following steps:

1. A progressive approach (often parallel), interleaving simulator training and real experience;
2. The use, wherever possible and appropriate, of part task simulators (PTS) dedicated to the acquisition of specific skills,
3. Reserve large and comprehensive solutions, such as shiphandling and bridge simulators, for situations such as team training which merit this level of simulation.

From the technical point of view, the starting point in considering the feasibility of implementing simulation at the SBGNI is to consider the principal factors affecting the overall training load year by year. This would depend on the training program of the particular year and the requirements of the training schedules for career advancement purposes in subsequent years. The main factors are:

- The number of ratings, junior officers and other personnel to undertake training.

- The amount of knowledge and range of skills they require.

Because of the range, and in many instances combinations, of knowledge and skills employed in the SBG and the additional requirement for military skills, the SBG cannot recruit directly from the work market. It has to train all its personnel, specially those in the lower ranks, as ratings and general workers. A considerable number of men enter the SBG each year. At any one time some 300 men are undergoing formal training ranging from basic training in nautical sciences, technician apprenticeship (ratings) courses, and special training for in-service personnel in new equipment to short refresher courses.

Due to the nature of the client the SBGNI serves, the point relating to numbers is restricted. Attrition due to retirement, accidents, death and other causes in the force is low, so the number the SBGNI takes every year is a direct result of the force expansion and specialisation demanded. This gives the extent to how many people to train.

4.4.1 The Amount of Knowledge and Range of Skills Required

A look at the SBG training scheme for all its personnel, specially for those considered in this dissertation, shows the extent of the task before the SBGNI.

.1 The Training Scheme and the Role Play by the SBGNI in the Overall Scheme

a. Professional Standards

It is SBG policy that officers and ratings be educated and trained to the highest possible standards in order that they may carry out their duties effectively and safely. For this, officers and ratings go through training steps, some of which are described below.

.1 Initial Training for Officers

Most of the young officers entering the force are graduates of the King Fahad Naval College: Others are graduated from academies abroad. On joining the SBG force all junior officers require a period of learning the rules, procedures and the way the SBG carries out its functions. They are mainly trained in law enforcement and advanced technical subjects before they take their first appointment.

General training and subjects are described in Chapter 2 of this dissertation. This stage is followed by practice onboard the training ship TEBUK and patrol boats, mainly for experiencing the practical aspects of life onboard patrol boats and practice procedures, including real-work along side experienced officers and ratings.

The final phase of common training for young officers of all specialisation is a period of fleet training in an operational patrol boat.. During this period, they will spend time attached to each specialist department, gaining experience of the responsibilities of each department and their interaction with each other. They will also continue to develop their skills as leaders. After this general training the junior officers join the force. After a period of working they will return to the SBGNI for refresher courses.

.2 Initial Training for Ratings

After a period of common education and training in general nautical or technical subjects, the cadets are selected for their sub-specialisation and go to the appropriate courses. There the apprentice will continue his training, leading to the rank of Petty Officer. The cadet will also include periods under training at sea, whenever possible or at a naval station, during which time the cadet will consolidate his training in the practical nautical environment. On completion of training all ratings will then be drafted to a patrol boat or naval station to consolidate the apprenticeship and continue their training.

b. Professional Development

.1 Officers

For his first appointment, the junior officer is required to study the way SBG is organised, law and operational procedures. This signifies that he has to attend the SBGNI for introduction courses and training on the specific boat to which he has been assigned. The examination by a senior officer of the relevant specialisation assesses the trainee's stage of professional and character development. On completion of his first appointment and required courses, he is considered to have qualified for his duties.

.2 Ratings

On completion of his apprenticeship at the SBGNI and sea training, the rating is available for a wide range of jobs appropriate to his rate and specialisation. His employment reflects his previous experience, level of ability and personal preference. Advancement will be determined by ability and will lead to jobs which increasingly demand more of his management skills.

c. Continuing Education and Training

.1 Officers

A limited number of graduate nautical officers read for a second degree mainly at World Maritime University (WMU) and the Arab Maritime Transport Academy (AMTA). Postgraduate training is a part of the SBG commitment to the highest standards of education and training for its officers.

.2 Ratings

Ratings' advancement is by examination and/or selection. Individual ships and departments are required to maintain continued training programs to prepare the candidates for examinations and to ensure that they gain the necessary breadth of experience to fit them for the higher rate. Examination is usually carried out by experienced officers. Selection is based on the comprehensive series of reports made on individuals throughout their careers. Advancement is followed by further career training to update technical and managerial skills, and prepare the rating for his new range of jobs.

Career courses for officers and ratings are designed to cover the most common equipment and systems currently in service. Personnel appointed to ships containing equipment with which they are unfamiliar receive pre joining training.

d. Future Training

The trend towards more sophisticated technology and reduced manning levels in future patrol boats will have an impact on the employment of officers and ratings, which must be reflected in their training. Training is acknowledged to be an integral and vital part of the support required by new equipment or classes of boats, and is included in the specification, design and funding processes.

The SBG is convinced of the importance of training. It is recognised that job satisfaction can only come if the individual is confident in his competence, based on proper levels of professional training. Training is important in maintaining correct standards and practices, and thus levels of safety. Although training is designed to meet the needs of the SBG, it is also recognised that the SBG officers and ratings must be trained to the highest standard. The SBG is increasingly a highly technological institution, operating and maintaining sophisticated equipment in the most demanding of environments.

Training to achieve the intended level of training is costly and the SBG must continually search for the most cost-effective ways of matching training to the needs of employment while considering value for money. However, as manpower levels in ships are being reduced, it is inevitable that an officer's and a rating's training will become more important, and that per-capita training investment must rise accordingly.

4.5 Objective training

To determine the training that a person or team needs in order to be able to carry out a particular job requires the following work to be done:

1. Analyse the job in detail to determine the knowledge and skills that are required to perform successfully.
2. From the previous work, prepare the operational objectives which describe what a trainee should be doing at the end of training, including on the job training.
3. Determine the elements which can be met by formal training
4. Prepare the training objectives which represent the highest level of trainable activity that can be achieved in the training establishment.

The main problems addressed in this dissertation is how to transfer knowledge and how the acquired knowledge can be tested. For that several methods could be used:

1. Examinations: this is the traditional method to test if knowledge has been transferred
2. Another method is repeating standard courses several times a year.

Both methods make it worth developing large question banks and then using multi-choice answers. In this way, training assessment and quality control are subjects for computerisation. Both methods are in use at the Institute.

However, new technology in the teaching-learning process would require the introduction of new ways to plan and design courses. This approach will require the consideration of training by objectives or objective training.

The main impact of objective training is that it forces course designers to look for economical ways to promote the acquisition of necessary skills and means for testing if the acquired knowledge is to the desired standard. This led to the search for skilled trainers and hence the use of simulators.

4.6 The Simulation Technology

In considering the use of simulation technology, the first consideration is that a simulator represents graphically the operational conditions of a ship through a trainee-
operator interfacing with a computer containing a model of reality. This reality can be varied either by pre-defined computer programs or by the actions of the instructor. The three key features of any form of simulation are:

1. It attempts to represent a real operational situation
2. It provides means of control over that situation
3. It is deliberately designed to omit certain parts of the real operational system.

A simulator definition for this purposes could be stated at this point: Simulation is any system used as a representation of real working conditions to enable trainees to acquire and practise skills, knowledge and attitudes. Simulation may be of either equipment or situations.

A simulator is thus characterised by the following features:

1. Imitation of real situation and/or equipment which may permit, for training purposes, the deliberate omission of some aspects of the equipment or operation being simulated.
2. User capability to control aspects of the operation being simulated.

Considerations for the reasons to simulate seem appropriate at this point, since most detractors of the technology sustained that since naval organisations possess expensive ships and equipment, it should suffice for these to be used for training purposes without the additional expense and overhead of simulators. (Hill, 1991)

In many areas the reasons for simulation are obvious. Such is the case of inaccessible and dangerous places, although the nature and type of simulators needed may require considerable study and good judgement.
When using objective training this gives emphasis to the use of simulators for skill training: Part Task Simulators for various processes have been in use for many years before introducing objective training. This makes it relevant to review the reasons for simulation rather than doing all training on full scale on standard operational ships and using available equipment, as might at first thought seem preferable and more economical.

Simulators should be used for training in the following cases:

1. A first case and an obvious one is if training on the real equipment would involve high risk or danger. If an unskilled person at the controls risks his own life, and others' lives, as well as being likely to cause expensive material damage, there are clearly grounds for considering a graded approach to learning through simulation.

2. A second case is due to the consideration that simulator training is often the most effective of all. Training can be extended into failure and emergency regimes without causing damage, and trainee performance can be readily monitored, analysed and assessed.

Simulator training requires structured training. This approach is used for individual and team training. For a wide variety of skills, simulator training is the most effective of all. It has the significant advantage that the rate of skills acquisition can be monitored and measured. Pace and intensity can be suited to trainee capability, and misconceptions and difficulties are quickly revealed and can be quickly corrected. In brief, simulators bring quality control to training in a way no other method achieves.

Also relevant is the degree to which it is necessary to train operators in the skills of controlling the process under fault or damage conditions or when to degrade the real machine or process in order to create the desired condition. This would be expensive, damaging or excessively risky.

Thus, the number of trainees and the skills in question are factors in the decision of whether to adopt a simulator approach to training or to develop operator skills exclusively in the real environment.

Even so, if only few people each year need to acquire the skills in question, it may well be cheaper and more effective to provide training 'on-the-job' with an experienced operator or training instructor able to take over if disaster threatens.

3. A third case for using simulation for training is that using real equipment would incur higher capital cost or operating cost, or both. A further factor may simply be the costs involved in creating the real environment needed for useful training to take place. It is extremely expensive to take a task force, for example, to sea and then subject it to real-like situations. Such full scale events are necessary, from time to time, to subject the material and training regime to scrutiny, and to sharpen state-of-readiness, but it is obviously sensible to first develop individual and group skills through structured progressive training before the expense of a full scale exercise is incurred.

Even the full scale exercise itself will not replicate the nature and scale of the job since, by definition, conditions are created for the exercise. The high level skills of task force command and control to facilitate the exercise can and are also acquired and practised in simulators.

4. A fourth reason to simulate is if the real situation for training purposes cannot be fully recreated by one's own resources or due to other restrictions.

In all four cases, and their combination, the main criterion to apply is to get the best value for money.

4.7 Value and Effectiveness of Simulator Training

Belief in the value and effectiveness of simulator training is now widespread. The pressure to maintain and improve training standards in the face of reduced crew numbers in ships, in a climate of tight budgetary constraints has an additional forcing effect on the use of simulators..

In 1985, a study was undertaken to evaluate the effect of training by shiphandling simulator relative to evaluation of skills levels for competence. (Muirhead, 1985). The report of the study concluded inter alia:

1. The technology provides a highly realistic medium for the mariner.
2. Many tasks can be reproduced in a simulator. The number depends on the sophistication of the equipment.
3. For training individual tasks, part task simulators should be integrated into the program as a way to train skills acquisition.
4. An increase in simulator shiphandling training produces a marked improvement in performance.

Other studies (Hill, 1991) have also shown that

1. The crucial aspect of effective simulation for training is that it represents task demand rather than reproducing precisely the operational situation.
2. Simulator-based training in visual navigation and blind pilotage transfer effectively to sea experience in a highly significant percentage of trainees.

The main conclusion of these studies though is that this form of simulator-based training can provide a positive and valuable contribution to navigational training.

4.8 The Economics of Simulation

The introduction of simulation technology into the curriculum of most MET systems requires substantial investments. The relative economic advantage of this technology over traditional methods of training and assessment has to be clearly demonstrated. The decision to allocate financial resources for the purchasing of a full mission simulator should be preceded by a cost/benefit analysis.

4.8.1 The Reasoning

This introduces the problem of defining the cost, or the value of an operational day of a vessel for use in a comparative costing exercise. By comparing cost and benefit of simulator training and exercise using real vessel or equipment or both a decision may be drawn. This comparison must clearly show that the procurement of a simulator is the most cost-effective means of meeting the training objectives.

In considering the capital and running costs associated with a simulator, consideration has to be given to the classical acid test questions of the economic reasoning.

4.8.1.1 (WHAT) Type of simulator to procure

Simulators range from relatively simple single-task units, used for individual skill training, to large units used for team training and needing many staff for their operation. Part task simulator, single task, full mission, static, ship motion, fidelity, visual systems, sound and noise, etc.

Fidelity: How far to go in simulating the full real environment when providing a training simulator. Each case must be considered on its merits and a few general rules can be made.

Visual Systems: Simulation articles and companies' promotional literature demonstrate the high quality visual effects that are currently available. There is a difference when considering types and classes of ships. While for merchant ships visual systems are of fundamental importance for navigation, when military craft are considered one has to pay close consideration to the real necessity of high resolution. In a warship and in patrol boats, few people need to see the outside world or use its visual information in their jobs. The potential requirement for simulation of sea, land, borderline, sky and other ships sharing the visible space out to the horizon is limited to simulations of the bridge, and weapons.

Nevertheless, in these applications visual systems play an important but distinctive role. In the case of bridge a simulator, however, the requirement is to train inexperienced operators, in the safe and proper command of a ship, where sea conditions, range of visibility and other climatic visual clues are important factors in the decision required of the officer of the watch.

When watching other ships with a view to taking appropriate action under the Rules of the Road (for preventing of collision at sea), and when searching a borderline for suitable fixing marks, movement is relatively slow but appearance, shape, and profile are crucial. This requirement clearly merits a high quality visual system able to represent a wide range of conditions in day, night, dawn and dusk.

An exception, however is a new helmsman trainer where standard ship fitted controls and instruments are replicated more cheaply, using commercial items. Here the aim of the simulator is to train skills of course keeping, and manual and verbal responses to helm and engine orders. The parts of the operation required to be authentic are the movement of the compass repeater in response to helm orders, under a range of speed and sea conditions, and the verbal orders and pattern of dialogue between officer of the watch and helmsman. Extensive replication of the environment, which in any case varies between classes of ship, would hardly be warranted for such a limited training objective.

4.8.1.2 (WHERE) To site the equipment

Centralised training system. Placing the main operating simulators for skill training at the Institute. This solution will incur in extra costs associated with travelling and accommodation for in-service personnel, while it is convenient for the Institute's students.

Decentralised training system or in operating bases. A decentralised policy is particularly relevant where:

1. The simulator operates independently and teaching operating skills do not depend on linking a number of different simulators.
2. Operators must make frequent periodic use of simulators to qualify, or to maintain qualifications in date;
3. A vessel type is associated with a particular operating base or port.

This solution, training simulators in the operating bases, is efficient in the use of people's time, and avoids travelling and accommodation costs. However, when the fleet operates different types of ships, training requires simulated operations rooms of different classes of ship, which makes this solution the most expensive of all.

On board ship The training facility is taken to the ship rather than the ship's personnel to the training facility. While the quality of the training that this simulation provides has the highest respect, it represents a significant capital investment and each new class of ship entering service brings the need for a new simulator operations room to be added.

This solution is sometimes unrealistic because the majority of simulators ashore are too big for deployment on ship. However, the use of simulation afloat could have particular benefits. Firstly, the actual ship equipment can be used by injecting training data into the relevant consoles. The method is convenient and involves less of a credibility gap and translation process during and after training sessions. Its immediacy and convenience enable the skill levels achieved during formal training and assessment, either ashore or during specific sea training periods, to be maintained throughout normal sea service.

The above elements are basically the ones to quantify. WHEN and WHY belong to decision makers.

4.8.2 Training for Personnel with Sea Experience

Once people have been to sea they view simulations in a new light. Rather than using them, as will new trainees, the sea experienced rating and officer will instantly recognise the extent to which the simulator replicates the real environment. Attempts to extend training beyond the limitations of the simulator's physical environment or its model will, with these sea experienced trainees, risk discrediting the training and the simulator. As Hill, (1991) has shown, these trainees recognise that simulator training affords an opportunity to test responses before doing the job in real time and circumstances at sea. They think themselves into the mood and the situation, thereby raising the level of self imposed pressure and stress to that which they know to be normal on the job.

In a broad sense the costs associated with experienced trainees is justified because every training session represents a good opportunity to validate responses given by newer trainees. Thus while simulators are excellent facilities for providing training in normal operations and the immediate actions to be taken in response to abnormal/ emergency events, they are only complementary to extensive live operation experience, and personnel must have a profound understanding of all aspects of the equipment they are responsible for operating. Every opportunity should be taken to validate and to enhance the fidelity of response of these trainers, but in some circumstances they will only represent a best estimate of how the real systems will most probably behave.

4.8.3 Simulator Motion

Nowadays personnel in the operations and engineering branches at sea spend all or part of their watchkeeping time operating at panels, keyboards and screens under artificial lighting, bright or dark according to circumstances. The crucial question is whether or not to provide ship motion simulation. To do so increases the cost of a simulator several fold. Basic simulators have no movement; the more advanced trainer adopts a single tilt angle representing list under damage conditions while the latest unit can roll realistically about a longitudinal axis. (Appendix A, Fig. A3)

4.9 Training for Stress

The right amount of stress has always been considered to be a good sharpener for producing the most effective training, and provides a self-knowledge which can only be of benefit to the individual when having to deal with real situations. It is therefore a topic closely allied to the use and justification of simulators. Stress and its symptoms and effects are well researched and well known, as is the knowledge that stress resistance can be improved by training and by familiarity with potentially alarming events and situations.

An important part of leadership courses and leadership training is to create stress and help students to recognise and cope with it. As far as possible this is done in ways which are independent of the skills, knowledge and environment of any particular branch or department, and hence the training takes place ashore, rather than on the high seas. The aim is not to teach orientating skills but to demonstrate the effects of stress, and the benefits of teamwork and straightforward leadership skills in coping with it.

Simulator training complements this training by allowing stress to be applied within the field of professional competence of the trainees. Stress is applied by stretching the trainee, either in terms of difficulty of the task or exercise, or by the frequency of incidents with which he has to deal. The general rule is that stress has no part during initial familiarisation training because to introduce stress at this stage could well inhibit the assimilation of information and obstruct the training process. During more advanced training, however, and during performance assessment phases, stress has a real part to play both in hardening the trainee to its effects and in assisting the process of learning through heightened awareness.

At the heart of the problem is the fact, however, that the more complicated the process an operator has to perform the more likely and the more potentially serious is degradation of performance under stress. Repetition, to the point of over-training, has been the traditional military solution. It is better for this to be done using simulators than buying up the time of operational units.

The assessments provide some opportunity to observe operators under stress. The stress is induced by the formality of the occasion, the natural pride of individuals who would wish not to be found inadequate when under observation, and by the manner in which the drills and sessions are applied. As an assessment session progresses, the trainees are pressed harder. New plant failures are imposed during operational conditions, which are already abnormal as a result of earlier un-rectified defects. Double failure exercises are used, any ambiguous instructions to the machinery spaces are misunderstood on purpose, expected expert assistance is not always available, and unimportant events are used as distractions during crucial moments.

Training of course must sustain realism and contain a balance of both pressure and encouragement, preventing any complacency by the competent operator but also creating some confidence in the inexperienced watchkeeper. Thus it is intended not that 'the training system' will win come what may, but :

1. if a trainee or team is good, let them demonstrate how good; their achievements can encourage others to raise standards overall;
2. if an individual or team is nervous, allow them first to gain some confidence in their own abilities; however,
3. if an individual or team is suspected under pressure, then their weaknesses must be exposed and remedial training given to correct them.

4.10 Operating a Simulator

Once it has been determined that the procurement of a simulator is the most cost-effective means of meeting the training objectives, the actual role of the device must be clearly defined. Even so the success and optimal use of a facility depends largely upon the imagination of the trainers. It is a great benefit if they have had similar training themselves, and are thus aware of the danger of overloading trainees. Further, recent operational experience is also highly desirable if not essential. Simulator instructors should be trained specifically in: brief - monitor - debrief techniques.

Instructors require highly capable facilities:

- Control consoles should be able to inject the full range of possible faults and changes in operating conditions.
- Instructors' operating positions should be situated such that the instructors have an unobstructed view of all systems and equipment at all times.
- Maximum use of any facilities which will reduce the instructors' routine workload and will permit them to concentrate on monitoring and assessing the trainee performance.
- Recording and replay facilities to analyse events and provide convincing

debriefing. Events which occur during a training session can be used to further the instruction of future trainees.

4.11 SBGNI Future Simulation Needs

There are many areas in the SBGNI and the SBG in general that the author identifies as potential for the use of simulators. In particular:

1. Shiphandling and navigation for the Institute's manoeuvring course programme, manoeuvring courses for pilots, emergency manoeuvring, navigational equipment (ARPA; radar, echo sounder. GPS, indicator of angular velocity, bow/stern thruster, means of communication, other bridge navigational equipment).
2. With bridge simulators now in quite common use in the merchant shipping field it is perhaps surprising that the SBG does not possess one. This deficiency is seen as priority one. This type of simulator is seen in this dissertation as an essential facility for maintaining and improving bridge watchkeeping courses.
3. Crisis management/emergency procedures
4. Bridge team management
5. Planning and manoeuvring techniques (man overboard, etc.)
6. Optimising patrol boats optimisation
7. Reconstruction of accidents
8. Engineering, maintenance and repair.
9. Firefighting training. Present training units are uneconomic and pollute the atmosphere.
10. The third area is ship and department administration.
    Using simulators for teaching office and administration skills. It is an important and essential facet of engineering management and simulation could play a much bigger role.

CHAPTER 5

SIMULATORS IN MET SYSTEMS

Traditional examination methods have been the way for testing students at the SBGNI, since its foundation in 1973. This situation can certainly continue in the same way, but there are new approaches worth considering, specially for the training on a large scale. This involves teaching a standard course repeatedly, year after year or for some courses several times a year. This is a case similar to the SBGNI.

Hill, R. C. (1991) pointed out that the introduction of the principles of objective training has permitted many MET institutions to document every aspect of the curriculum, step-by-step, and task-by-task. These methods have had a major impact in the area of training costs. It has allowed MET institutions to choose a method for promoting the acquisition of skills and for testing that skills have been acquired to the desired standard, at a reasonable cost. Task analysis has led directly to the search for better methods for skill trainers, hence to the development and intensive use of simulators.

The success of the new teaching-learning strategies has made the standardisation of this method one of the goals of the STCW 95. This IMO Convention guides governments in the adoption of model courses in simulation and makes compulsory the use of radar simulation training and recommends the implementation of simulators in other maritime subjects, as an effort to standardise the level of training.

In the same way educational programmes differ from country to country, MET institutions have developed different approaches to simulator training. This chapter gives an outline of the structure of training in several MET institutions around the world and shows the extent to which simulators have become fundamental to the training of all types of personnel in all fields of maritime employment.

The introduction of simulators, into the curriculum of MET institutions is the result of pressures for changes in the maritime industry. Many countries have confronted the problem of re-examining and restructuring their MET systems for ratings with changes in methodology and adopting new systems to face those demands.

Stories of considerable success in the implementation of new MET systems and the reorganisation of their maritime sectors can be seen in Australia, Germany, Japan, Norway, the UK and others.

One way to approach the introduction of simulators into the national MET system of any country is looking into the systems of trend-setter countries. While the STCW '78 Convention was a guide in the formulation of the systems, due to the stage of development of the countries mentioned, the minimum standards set by the STCW 78, and the STCW 95, have been surpassed. In order to gain from these experiences a compromise has to be drawn here, adopting and implementing the recommendations of the STCW 95 and understudy these countries' systems.

The countries selected for comparative studies are Australia, the UK and Germany. These countries have all introduced the use of simulators in their MET systems and naval schools.

5.1 Australian Maritime College (AMC)

The mission of the Australian Maritime College (AMC) is to provide maritime education and conduct applied research of international distinction, in keeping with the needs of the Australian maritime industries.

The main goals of the AMC are to provide quality education, implement a continuous quality improvement program and develop profiles that reflect changing industry, community and AMC needs, among others.

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

The Krupp Atlas shiphandling simulator has the capability of displaying up to 20 ships in traffic during daylight and night situations, with rear and side views as required.

The Norcontrol radar and navigation simulator consists of 4 own ship, each equipped with radar, ARPA, controls and displays.

AMC has in operation a situation monitoring system (SIMON), with its own debriefing facility and real GPS receivers interfaced to the simulators. This facility has a fully equipped control room to hold simulation exercises subjected to control, monitoring and recording by instructors.

Training courses such as radar, ARPA electronic navigation aids, watchkeeping and shiphandling skills were integrated into the deck officer Diploma in Nautical Science scheme, with the help of the Krupp Atlas shiphandling simulator. The training programs using simulators include the following:

Training	**Duration**
Radar surveying	3 weeks
Radar observer	3 weeks
Radar simulator	5 days
ARPA	3 days
Pilotage and radar	3 days

Training by simulator is extended to the certificate of competency courses. This comprises:

Pilot's Shiphandling course .... 5 days
Advanced Navigation and ARPA course ..... 5 days
Advanced Navigation only .... 2 days
Ship Master's Shiphandling course .... 4 days

The pilot's shiphandling course provides first time experience for the inexperienced and the opportunity to enhance and develop the skills to experienced mariners. The course is organised on a workshop basis which covers both lectures and practical training. The advanced navigation and ARPA courses are aimed at officers in charge of a navigational watch on ships fitted with ARPA.

The objectives of the ship master's shiphandling course are to examine shiphandling theory and current practice, and to provide practical experience under simulation of the handling characteristics of various types of vessels.

A continuous simulation training program was introduced at the AMC with the objective of making the simulator available to students for training purposes.

During the training session students have full control of the simulated ship by means of a special computer program. Every student receives an instruction manual and briefed on the exercise. They receive the objective and other information on the exercise, the relevant publication required, questionnaire, computer operating instruction, etc.

The simulator sessions are designed to meet particular objectives: manoeuvre- turn a ship short-round in a navigational channel with no wind or tide. Once the exercise has been completed, results are printed out, questionnaires are answered and all the entries of the simulation logbook completed. The instructor has in his possession copies of all exercises conducted for monitoring purposes.

5.2 United Kingdom. The Maritime Operations Centre , Southampton

The navigation and shiphandling simulation facilities at the Maritime Operations Centre of the Southampton Institute comprises the following:

Manned Model Shiphandling

Bridge Simulator

Radar and VTS Simulator

5.2.1 Manned Model Shiphandling

The manned models courses have six model ships ranging from 40,000 DWT to 500,000 DWT tonnes in a 13-acre lake. The course is designed to improve the training of personnel in shiphandling at the berth approach phase. It is thought to compensate for some shortcomings left by simulators in the harbour approach phase, in waters subjected to pilotage. The training program consists of:

.1 A standard Manned Model Shiphandling course (5 days)

This course is directed to develop officers' skills and understanding of the concept involved in shiphandling on slow speed ship control. The practical exercises undertaken are supplemented by discussions and films.

.2 Special Manned Model course

This course is aimed at specific training needs and is conducted under special arrangements.

.3 Basic Pilot Training course (3 weeks)

This course is designed for new entrants to a pilotage service before their shipboard training.

.4 Advanced Pilot Training course (2 weeks)

This course is designed for pilots in their last phase of their training program and for pilots on-service.

5.2.2 Bridge Simulator

The bridge simulator comprises a Norcontrol simulator and a Racal-Decca simulator. The Norcontrol simulator was commissioned in 1993. It has the following facilities: telegraph , combinator/throttle , ARPA, twin VHF, internal telephone, Doppler log, Radar, GPS, Decca Navigator, Loran C, DF and Echo Sounder, steering console and magnetic compass.

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

The instructor's station consists of two consoles together with seven colour monitors which show the same 210 degrees scene as that on the bridge. Each exercise is recorded and can then be played back on a console during debriefing. The action and speech of those on the bridge are monitored on video tape.

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

The simulation training program comprises:

1. Bridge Team Management course (5 days)

It is aimed at officers and the need for planning the vessel's passage from berth to berth and the optimisation in the use of manpower and equipment.

2. Bridge Watchkeeping Preparatory course 2 weeks

The course is designed for deck cadets in their last stages of the training. The aim is to consolidate the training for potential officers and prepare them in all aspects of watchkeeping duties. On completion of the course a remission of six weeks sea service is granted.

3. Emergency procedure course (3 days)

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

4. Ship Simulator Operator's Training course flexible

The ship simulatot operator's training course is flexible and designed to train the staff of establishments who are purchasing ship and radar simulators to be efficient operators..

5. Basic Pilot Training course (3 weeks) and

6. Advanced Pilot Training course (2 weeks)

7. Special courses

Special simulation courses are frequently adapted or designed to meet the specific training needs of the client organisation.

5.2.3 Radar and VTS simulators

The radar and vessel traffic services (VTS) simulator facilities have four own ships installed by Racal Simulation. A Norcontrol simulator (dedicated to VTS) has a complete range of navigational aids interfaced to the simulator including Decca Navigator, Loran C, satellite Navigator, ME/DF, Echo Sounder, Fog Signals and

Multi-Channel VHF. One own ship is additionally fitted with a Racal Raster "Brightrack" radar. The current courses provided are:

Navigation Control

ARPA

Radar/ARPA updating for pilots

Radar Surveyors.

Updating plus VTS for pilots

Radar Appreciation for Small Craft Personnel

Radar/ARPA appreciation for electronic maintenance personnel

Radar/ARPA updating for masters and navigating officers

Radar/ARPA training for high speed ferry personnel

Radar Simulator operator/lecturer

Radar/ARPA appreciation for legal personnel

Small Vessel navigation and radar course for personnel who do not currently require statutory certification in the use of radar and navigation aids.

VTS Management course

VTS and Maritime Training course.

Special VTS Training courses to the particular-requirements of individual port authorities.

This facility is also used for other training programs and research. The training programs consist of master/chief mates, pilots, VTS operators, shiphandling simulator instructors and special courses as demanded by the clients. The courses are designed for two levels of trainees: the experienced and non or low experienced.

The masters and chief mates courses have a duration of three to five days, depending on the own-ship size and manoeuvrability. The container vessels as own-ship cause the course to be a three-day course because the container vessel is relatively fast and so the number of simulator runs per hour are more. In contrast the tankers and large bulk carriers are slow and need lengthy exercises.

These courses cover manoeuvring characteristics, berthing and unberthing, giving assistance to a hampered vessel, the master-pilot relationship and risk management. The weather conditions on exercises are mostly arranged to be difficult conditions at this level. These courses are mainly aimed to teach the trainee the method of safe and economical ship operation, familiarise the masters with developing strategies of passage planning in such a way to avoid errors and to enable the chief mates to assist masters in difficult situations and to be able to take over command in every condition.

5.3 Germany, School of Maritime Studies - Hamburg,

The shiphandling simulator courses of Hamburg Maritime School run at a "shiphandling and simulation facility" called SUSAN (Schiffsfuhrungs Und Simulations Anlagen) is one of the most advanced and sophisticated simulation facilities in the world.

A large horizontal field of view, sophisticated monitoring system, motion platform and highly trained staff make this facility one of the best.

The school of maritime studies conducts ship operation officers courses. The course consists of eight semesters. Students with two and a half years professional training and carrying a multipurpose rating certificate join the school and study full-time for four years.

Those who successfully pass the course receive a diploma of Engineering and are issued with the 1st level watchkeeping certificate. Thereafter, they have to serve on ships as watchkeeper officers for 36 months equally on deck and in the engineroom to qualify for a master, as well as a chief engineer, certificate without further examination.

The first two years at school are mainly basic studies plus the fundamentals of navigation, seamanship and engineering. The main studies are carried out in the third and the fourth years. The lectures of navigation, seamanship and communication may be supplemented by the simulator whenever the lecturer decides it is suitable. The simulator at this stage is mainly used for lecture supporting exercises such as demonstration of manoeuvring characteristics, familiarisation with equipment or navigational aids training.

The main simulation training, which is radar simulator training and shiphandling simulator training, is done in the last semester. The students receive the main simulator training at a final stage before they go to sea.

The total simulator training for each student is about 81 hours consisting of 45 hours of radar training and blind pilotage and 42 hours of shiphandling exercises. Each student receives about 12 hours of command time in watchkeeping and shiphandling. The simulator training program covers passage planning, bridge watchkeeping, collision avoidance, approaching and communication in general, one man bridge watch, berthing and unberthing, taking a pilot, emergency anchoring, search and rescue and tug handling in particular. The exercises are done in day and night conditions, bad visibility and different wind forces and weather conditions. The first four sessions are done with six students present on the bridge. The rest of the exercises are done by three students except the one man bridge watch, which is obviously done by one student.

The exercises are spread over 9 to 11 successive weeks, each week with one or two sessions. The radar simulator training is done in parallel with the shiphandling simulator training in the same weeks. Students are briefed a few days before the exercise. Each session consists of a series of exercises and debriefing by the instructor after each exercise. The student maintains the roles of helmsman, navigation assistant and officer of the watch in turn.

The course aims to train the promotion of correct decision making by the officers. The main objectives of the courses are to enable the students to carry out all watch officers' routine tasks and to make use of the theoretical subjects they have learned in practical shiphandling and taking proper action.
The school runs a course for ship engineers who wish to achieve an additional nautical qualification for promotion to ship operation officer. The course consists of two semesters. The program contains nine sessions. In the first three sessions the students participate in groups of six trainees and for the rest of the sessions three students form a bridge team. The course covers watch procedures, passage planning, internal and external communication, emergency manoeuvres, collision avoidance and shiphandling.

The course aims to train students to be able to carry out watch officers routine tasks, to select and evaluate information needed for proper decision making within the man-ship-environment system. The student will be able to handle the vessel in different conditions including system malfunctions.

The facilities at the simulation centre in Hamburg consist of

A shiphandling simulator

A Krupp Atlas Electronic (KAE) radar simulator and

Radar and navigation systems

The radar facility has three own ships holding forty targets, each equipped with a KAE ARPA 8500 and a KAE 6500 radar which can be linked with the shiphandling simulator at the Ship Operation and Simulation Facilities (SUSAN)

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

Masters:
Chief Mates:
Watch officers:
Cadets with seagoing experience:
Cadets without seagoing experience
Pilot -apprentices
Pilot experienced
VTS-operator-apprentices with seagoing experience:
VTS-operator-apprentices without seagoing experience
VTS operators , experienced
Ship handling simulator instructors with simulator experience:
Shiphandling simulator instructors without simulator experience

Masters a 3-day course in container vessels, or similar, and a 5-day course in tankers (VLCC) or bulk carriers. The objective of this course is to familiarise the master with all routine tasks as well as to develop a strategic plan to avoid errors, involve the officers in the decision making process and to cope with emergency situations which may arise within a risk management program.

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

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

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

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

Cadets without seagoing experience (8 hours per day). Knowledge gained from the previous theoretical subjects taught is put together to form a shiphandling simulation which the student has to understand and, be able to evaluate in order to define proper actions. Student must know the governing parameters influencing the man-ship-environment system.

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

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

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

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

VTS-operator-apprentices without seagoing experience: The participants need to become familiar with shiphandling under various conditions.

VTS operators with experience: They need to know, understand and to apply VTS-strategies for situations and conditions which led to casualties, in order to derive strategies to avoid future accidents.

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

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

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

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

The pilot courses are of 5 days duration and mainly cover the handling of various sized vessels, operating all common bridge equipment, conning the vessels, master pilot relation, berthing and unberthing, use of tugs, communication and emergency situations. These courses are mainly aimed at enabling the pilots to make the correct judgements of a vessel's manoeuvring behaviour and to establish an effective master-pilot relationship.

The VTS operator, shiphandling instructor and special courses are mainly designed according to the needs and objectives of clients and the experience of trainees.

5.4 Bremen Polytechnic, Germany

The Department of Navigational Studies trains sea-going masters, and courses for limited tonnage, coastal range nautical certificates. The College has started new training programs for training dual qualification officers. The master's course takes about three years or six semesters of college studies which include three semesters of fundamental studies, two and a half semesters of marine engineering studies and two and a half semesters of nautical studies. The simulator training is done for both groups in the two final semesters.
The college is equipped with three manoeuvring simulators, a radar simulator, a shiphandling simulator and a navigation light simulator (nocturnal). The college is equipped with a liquid cargo handling simulator as well. The shiphandling simulator was the first one in the world to be designed, developed and built solely for a nautical training establishment.

The shiphandling simulator visual system is a CGI type with 90 degrees horizontal view. It operates three own-ships, a general cargo, a container vessel and a VLCC tanker.

The radar/ARPA and collision avoidance training are done in radar and nocturnal navigation light simulators. The training by shiphandling simulator is mainly aimed at familiarisation with ships' manoeuvring characteristics and shiphandling.

The total number of 44 hours of simulator training in eight sessions is provided in the 5th and 8th semesters for the Master certificate. The initial simulator training has to be done after or parallel to the theoretical lectures.
In the 5th semester exercises for students cover the following areas:
-Familiarisation with the simulator including demonstration simulator run.
-Filling up the manoeuvring tables of own ship via performing trial manoeuvre.
-Execution of turning circle with various speed, drawing turning circle diagrams.
-Constant various turn technique (CRT), calculation of ROT/speed values.
-Hand-over-board manoeuvring technique
-Search and rescue: execution of different patterns
-Turning ship on the spot from stand still condition within a limit
-Manoeuvring in bad weather, track keeping

The exercises are done by a general dry cargo ship as own-ship because it is easier to handle for the less experienced students. The exercises in the final semester are almost of the same nature but with VLCC tankers and loaded container vessels as own-ships. In the 6th semester exercises cover the additional areas such as:
-Understanding of power/weight ratio and plotting the changing course and speed tables/diagrams.
-Sailing in narrow fairways.
-Emergency situation, rudder and engine malfunction.
-Passage planning. execution and monitoring. The simulator training in Bremen engages students in data collection and documentation such as drawing manoeuvring curves and diagrams. This gives the students a better understanding of manoeuvring

characteristics of other ships from the tables even before they actually manoeuvre the ship.

External courses of radar/anti-collision training, ARPA training and shiphandling and pilot training are conducted regularly at Bremen Polytechnic. These courses are of advance training, updating and refreshment nature. The courses are normally of one week duration and have been offered for masters, mates and pilots.

The courses for masters and mates look at the behaviour of ships in different environmental conditions. The courses contain the search and rescue technique, man-over-board, single buoy mooring, berthing and unberthing and navigation in fairways and narrow channels. The courses for pilots aim to show the ships' behaviour under irregular circumstances. The exercises are done in fictitious areas and in pilots' own-port areas with different ship types.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

For 23 years the SBGNI has been graduating ratings in the nautical, engineering and maintenance areas. Graduates work exclusively for the SBG, in compliance with orders emanating from the General Directorate of the SBG. To be able to carry out its training and teaching assignments the Institute adopted methods and equipment described in this dissertation.

Training, teaching, skill acquisition, assessment of competence, testing, and other activities could certainly continue to be done in the same way, were it not for the demands that the new technological developments in the maritime field require of MET systems, no matter its nature: naval or merchant.

The existence of a training ship is no longer a guarantee for trainees to acquire the skills required on board ships. The fact is that trainee watchkeepers are not having the chance to practise what they have been taught at the theoretical level. Everyday that passes, the gap between theory and practice gets larger in this way.

With time those methods have proven to be insufficient to train the deck and machinery personnel that the organisation needs. New teaching and skills acquisition methods are necessary due to the technological advances that the nautical fleet is experiencing.

Parallel to the Institute's efforts, during this time, the maritime industries of the world have been involved in one of the biggest technological revolutions that has hit any industry. The past 30 years have seen great advances in many areas of naval and merchant vessels and equipment technologies.

New technology has been introduced over the past decades by many manufacturers in the area of ship automation and instrumentation. Microprocessors and software technology are now used in automatic radar plotting aids (ARPA), radar systems, electronic chart display and information systems, position-fixing systems, autopilot and other bridge systems, and communications between subsystems have been improved through the use of standard computer networks.

Computers onboard ships were introduced in 1966, mostly of the analogue and electro-mechanical type. The first efforts to duplicate the behaviour of a ship under control conditions in the marine field dated back to 1968. The first ship's bridge simulation appeared in Göteborg, Sweden and the Netherlands.

The first microprocessors were promptly used in training in 1973. The introduction of the PC, the growth in both the power and applications of the PC and continuing cost reductions have made a dramatic change in ship systems and operations onboard a ship.

Some of the typical instruments used on board vessels today include: automatic data collection (the navigation computer) and distribution (the marine network), GPS (Global Positioning System), Loran-C, Decca, Satellite Navigation System, Omega, gyrocompass, the radar, the gyropilot, Graphical Data Display/Electronic Chart, Automatic Data Logging, Voyage Planning and Monitoring, among others. This equipment uses computer hardware technologies.

It is known that seafarers have not always been able to use modern navigation technology without endangering safety at sea and the marine environment. Lack of training and over-confidence in technology have resulted in marine casualties.

The lesson learned over time has been that modern navigation equipment has to be operated by navigators who have a good understanding of the possibilities and limitations of the equipment. Seafaring personnel have to be trained in the use of modern navigation technology.

For operating today's technologically sophisticated ships and machinery, conventional methods of training really need to be supplemented. Stiffer requirements are imposed on the operating personnel. Practically oriented training appears to be the only way to counter act this trend.

The aim of this dissertation has been the finding of a modern method of teaching and training skills, according to the technological advances experienced by ship design and handling, as well as their instrumentation in the last decades. For this, consideration of the STCW 95 is instrumental, because it summarises the latest international requirements regarding training.

Throughout this dissertation, the author has advocated that training and skill acquisition in the maritime field should develop the attitudes that have characterised other industries, such as aeronautics, nuclear power plants, space research, the automobile industry, chemical plants, and business, where the use of simulation as a training tool is not just recognised, but it is indispensable.

The use of objective learning has become standard practice for MET programmes in many institutions around the world. However, the use of specific learning objectives is limited for those schools lacking hands-on facilities. In these cases, training continues to be separated from many operational shipboard practices, and this is the case of the SBGNI.

However, new technology in the teaching-learning process would require the introduction of new ways to plan and design courses. This approach will require the consideration of objective training.

The main impact of objective training is that it forces course designers to look for economical ways to promote the acquisition of necessary skills and means for testing if the acquired knowledge is to the desired standard. This led to the search for skill trainers and hence the use of simulators.

The main premise of this dissertation is that the new technology of simulator- based training provides an alternative for solving this problem. In simulators the trainee can acquire the necessary operational skills, with no risk to himself, the ship, property or the environment, in a shorter time than the required by traditional methods.

Simulation is based on the imitation of natural and technical processes. Visual and acoustic impressions, floor oscillations, centrifugal forces, vibrations, radar and sonar displays, and instrument scales in control rooms, can be displayed and generated without difficulty. The greater the desired realism of the simulation, i.e. the larger the number of instruments displays or of impressions for the senses, the higher the computing power required, the more expensive it is.

A simulator definition has been considered: Simulation is any system used to represent real working conditions, to enable trainees to acquire and practise skills, knowledge and attitudes. Simulation may be of either equipment or situations.

Simulators are manufactured in different categories from the representation of a single task, a part task, including several singles and up to full mission simulators, which are capable of reproducing a total bridge environment, static, ship motion, fidelity, visual systems and sound and noise.

There are differences in marine simulators. The main differences are in visual display systems. They all display the ship environment on the screen outside of the wheelhouse with a certain horizontal and vertical field of view normally between, 120 and 360 degrees. The visual display systems vary in technique, ranging from discrete slide pictures to sophisticated computer generated images (CGI).

Over the years different projection systems have been developed: the model board system, the shadowgraph, slide protection system, the nocturnal display, and the computer generated image (C.G.I) visual display

Considerable experience in the training and assessment of mariners through simulation has been acquired over the past 15 to 20 years by institutions, many of whom exchange their training experiences through the auspices of the International Marine Simulation Forum (IMSF) and the International Maritime Lecturers Association (IMLA).

Newer simulators include the provision of built-in instructor evaluation systems by companies such as Norcontrol, PC Maritime and Transas Marine.

Reasons for using training by simulator are many. Training on real ships involves high risk or danger, training on simulators are risk free; it can be extended to failure and emergency situations without causing damage. Trainee performance can be readily monitored analysed and assessed. Real ships would incur higher capital cost, operating cost or both. The repeatability of training exercises can not be achieved in real ship conditions.

One of the main advantages of simulator training is time saving. It means tasks that should have been done on board ships in the lengthy course of time can be trained in a short period of time in simulators.

There is no need for long journeys to the exercise location or for waiting times. Weather and other ambient conditions are immaterial, so no training time is lost. Wear and tear of the plant or equipment is avoided, as is the necessity to take a plant out of operation for training.

Simulation systems can also be employed in planning and development in order to test the characteristics of a vessel, vehicle, plant or other item of equipment even before a prototype has been built. After the actual plant or equipment has been put in operation, simulation systems can also assist in analysis of accident situations and malfunctions that have occurred in reality.

Due to the nature of the SBG functions, the use of simulation is highly convenient in such cases of inaccessible and dangerous places. This device can help develop the necessary skills. This makes it relevant to review the reasons for simulation rather than doing all training on full scale on standard operational ships and using available equipment, as might at first thought seem preferable and more economical.

Simulators should be used for training in the following cases:

1. If training on the real equipment would involve high risk or danger
2. Training can be extended into failure and emergency regimes.
3. If using real equipment would incur higher capital cost, operating cost, or both.
4. If the real situation for training purposes cannot be fully recreated by one's own

resources or due to other restrictions.

Studies conducted in the 1980s to evaluate the effect of training and skills acquisition by shiphandling simulator demonstrated that :

1. the technology provides a highly realistic medium,
2. many tasks can be reproduced in part task simulators, and
3. an increase in simulator shiphandling training produces a marked improvement in performance.

Other studies have also shown that the crucial aspect of effective simulation for training is that it represents task demand rather than reproducing precisely the operational situation and that simulator-based training in visual navigation and blind pilotage transfer effectively to sea experience in a highly significant percentage of trainees.

In spite of all this, it is still necessary to show the comparative costs of providing simulation training versus an equivalent training in real vessels and with real equipment. This introduces the problem of defining the cost, or the value of an operational day of a vessel for use in a comparative costing exercise. By comparing cost/benefit of simulator training against the use of a real vessel and equipment, or using both alternatives in the same exercise a decision may be drawn.

The main variables when considering the implementation of a simulator project are fidelity, visual systems, location of the equipment and motion.

Once it has been determined that the procurement of a simulator is the most cost-effective means of meeting the training objectives, the actual role of the device must be clearly defined.

One of the most important uses of simulators in armed forces today is the training for stress. This is a topic closely allied to the use and justification of simulators. Stress resistance can be improved by training and by familiarity with potentially alarming events and situations. Simulator training complements this training by allowing stress to be applied within the field of professional competence of the trainees.

Even so the success and optimal use of a facility depends largely upon the imagination of the trainers. It is a great benefit if they have had similar training themselves, and are thus aware of the danger of overloading trainees. Furthermore, recent operational experience is also highly desirable if not essential. Simulator instructors should be trained specifically in: brief - monitor - debrief techniques.

Three elements to take into consideration in the installation of new facilities were considered: guidance in instructional techniques, practical simulator operational experience and practical assessment experience on the simulator. A number of options are available: manufacturer's training programs, learning on the job, understudying at another institution experienced in simulator training and operations, the IMO model courses (1.09 Radar simulator, 1.22 Shipsimulator and Bridge Teamwork, 2.06 Cargo and ballast handling simulator, 2.07 Engine room simulator, Training course for instructors).

All these modules can assist in the development of basic instructional techniques. However, if instructors and assessors follow the guidance provided in the new STCW 1995 Code, they will be following in the footsteps of many experienced simulator operators who contributed through the STCW Sub-Committee to the development of such standards.

Although many MET systems are convinced as to the effectiveness of simulator training, there are still conflicts of opinion on this issue. Also questions are raised as to whether it is proper to train students under simulated conditions. Critics maintain that simulators are no substitute for real hands-on experience on the ship. Others say that organisations, such as the SBG, have all kinds of expensive vessels and equipment where training could take place.

In 1983 ship simulators were regarded as a useful aid to maritime training. Today, the STCW 95 considers them as essential in training of skills. There is no doubt that simulators are here to stay and that their use is set to increase.

The 1995 STCW Convention pays attention to the problem of training seafarers on the latest equipment and places emphasis on skills acquisition and demonstration of ability to perform tasks. One of the main features of the revision is the adoption of the STCW 1995 Code, to which many technical regulations have been transferred. Part A of the Code is mandatory while, Part B is recommended.

The modernization of the curriculum and syllabuses of the Institute would depend on the adoption of the following STCW 95 regulations and the relevant parts of the Code: Annex to the Convention, Chapter I, Regulation I/12 Use of Simulators, Annex 1, Part A of the Code, Section A-I/12, Standards governing the use of simulators, Annex 2, Part B, of the Code Section B-I /12 Guidance regarding the use of simulators, Chapters II, III and IV and VII of the Code Part A, Standards of competence for deck, engineering and radio operators, Annex to the Convention, Chapter I, Regulation I/6, and Annex 1, Part A of the Code, Section A-I/6 Training and assessment, Annex 2, Part B, of the Code Section B-I /6 Guidance regarding training and assessment, Chapter VII of the Convention on Alternative certification, Annex 1, Part A of the Code, Section A-I/8 Quality standards, Annex 2, Part B, of the Code Section B-I /8 Guidance regarding quality standards.

6.2 Recommendations

To accomplish the modernization of the Institute, the following recommendations are proposed :

In the area of modernisation of the training programmes, the Institute should :

1. modernise the curriculum and syllabuses based on the adoption of the STCW 95 regulations and the relevant parts of the Code,
2. investigate the technological developments in MET systems in general and in training, skills acquisition and assessment of competence in particular,
3. investigate the use of modern methods of objective training,
4. search for modern methods of teaching and training skills according to the technological advances,
5. adopt new teaching methods for the training of those skills required on board ships,
6. adopt new ways to plan and design courses according to the new technology in the teaching-learning process, and
7. adopt a structural planning approach for MET training, a system for internal monitoring training activities as to detect deficiencies and take appropriate corrective actions.

In the area of simulator training and assessment, the Institute should :

8. investigate the use of simulators in shiphandling, bridge simulators, crisis management, emergency procedures, planning and manoeuvring techniques, as well as patrol boats operations, reconstruction of accidents, firefighting training, administration and supply, and administration skills;
9. adopt a progressive approach, whereby the introduction of part-task, single task simulators, allow the integration of larger schemes at a later stage;
10. study the possibility of integrating part task simulators into the program as a way to train skills acquisition;

11. search for skilled trainers, part task and single simulators, as an economical way to promote the acquisition of skills;
12. use shiphandling simulation training as a means to improve performance;
13. investigate the possibilities that computer software and communication networks can offer for training of seafarers;
14. investigate the use of simulators as a training tool for high risk training, failure and emergency situations, analysis of accident situations and malfunctions;
15. investigate the main variables involved in the selection of a simulator, such as fidelity, visual systems, location of the equipment, motion and the cost of providing equivalent training in a real vessel;
16. adopt the use of simulators for training in cases where developing skills in the real equipment involve high risk or danger or incurs higher capital and operating costs;
17. investigate the use of simulators for stress resistance training.

In the area of appointing Instructors for simulation training, the Institute should :

18. adopt a policy to contract well trained simulator instructors, specifically in briefing, monitoring and debriefing techniques;
19. adopt the policy to contract qualified instructors according to the recommendations of the Code.

In the area of purchasing and installation of simulator facilities, the Institute should :

20. carry out a financial/economic analysis
21. investigate the best way to acquire experience, by means of manufacturer's training programmes, learning on the job, or by using the experience of other MET institutions in simulator training and operations and the IMO model courses.

In the area of quality standards (QSS), the Institute should :

22. develop a policy for the administrative, academic and support levels as well as standards of courses, a method or technique for quality control, a systematic monitoring arrangement, an internal periodical evaluation of the objectives to ensure that corrective mechanisms are in place and operative, to allow an independent evaluation of the training activities, the administration, qualifications and the institutional framework;
23. establish a validation process to measure the results of training to ascertain whether the behavioural objectives specified in the program are being met;
24. adopt the national quality standards system for training, assessment, certification, endorsement and revalidation of seafarers' certificates of competence, following the STCW 95 requirements.

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APPENDIX A

TABLE A1. WORKLOAD OF OFFICER COURSES PER CATEGORY

	Total Hours/Subject	Percent of Total	Percent / Category
TOTAL HOURS	**6869**	**100%**	
GENERAL INSTR.	**1261**	**22,36%**	**100%**
NAVIGATION	**1448**	**25,67**	**100%**
Oper. research	288	4,19%	19,89%
Radar engineering	48	0,70%	3,31%
Naval Engineering	82	1,19%	5,66%
Building/stability	154	2,24%	10,64%
Practical Nav.	96	1,40%	6,63%
Celestial Nav.	72	1,05%	4,97%
Plotting (Nav.)	48	0,70%	3,31%
Seamanship	96	1,40%	6,63%
Radar sets	222	3,23%	15,33%
Trans. & Rec.	164	2,39%	11,33%
Navig. equipment	178	2,59%	12,29%
SHIP OPERATION	**489**	**8,67%**	**100%**
EL&ELECTRO E.	**2873**	**50,94%**	**100%**
Navig. equipment	178	2,59%	6,20%
Naval Engineering	82	1,19%	2,85%
ADMINISTRATION	**789**	**13,99%**	**100%**

APPENDIX A

TABLE A2. WORKLOAD OF PETTY OFFICER COURSES BY CATEGORY

	Total hours per subj.	Total Percentage/subj.	Percentage in category
TOTAL HOURS	**22 914**	**100%**	
GENERAL INSTRUC.	**9456**	**41%**	
NAVIGATION	**4026**	**18%**	**100%**
Seamanship	1437	6,27%	35,69%
Communications	95	0,41%	2,36%
Rules of the Road	89	0,39%	2,21%
Chart Work	193	0,84%	4,79%
Celestial Navig.	108	0,47%	2,68%
Pract. Train. at Sea	373	1,63%	9,26%
Naval Organization	15	0,07%	0,37%
Naval Vessel	30	0,13%	0,75%
Naval Signals	22	0,10%	0,55%
Principles of Radio	44	0,19%	1,09%
Compass	29	0,13%	0,72%
Rope/anchor work	81	0,35%	2,01%
Safety	30	0,13%	0,75%
Ranges Bearing	14	0,06%	0,35%
Training onboard	1189	5,19%	29,53%
Nav. equipment	131	0,57%	3,25%
Ship Build/Stability	93	0,41%	2,31%
Electr. Navigation	53	0,23%	1,32%
SHIP OPERATIONS	**1601**	**7%**	**100%**
Naval Eng./Ship buil.	319	1.39%	19.93%
Ship Build/Stability	93	0,41%	5,81%
Training onboard	1189	5,19%	74,27%
ELEC&ELTRO ENG.	**4349**	**19%**	...
MAINTENANCE	**1477**	**6%**	...
SPECIAL COURSES	**558**	**2%**	...
ADMINISTRATION	**665**	**3%**	...
TRAINERS COURSES	**50**	**0,22%**	...

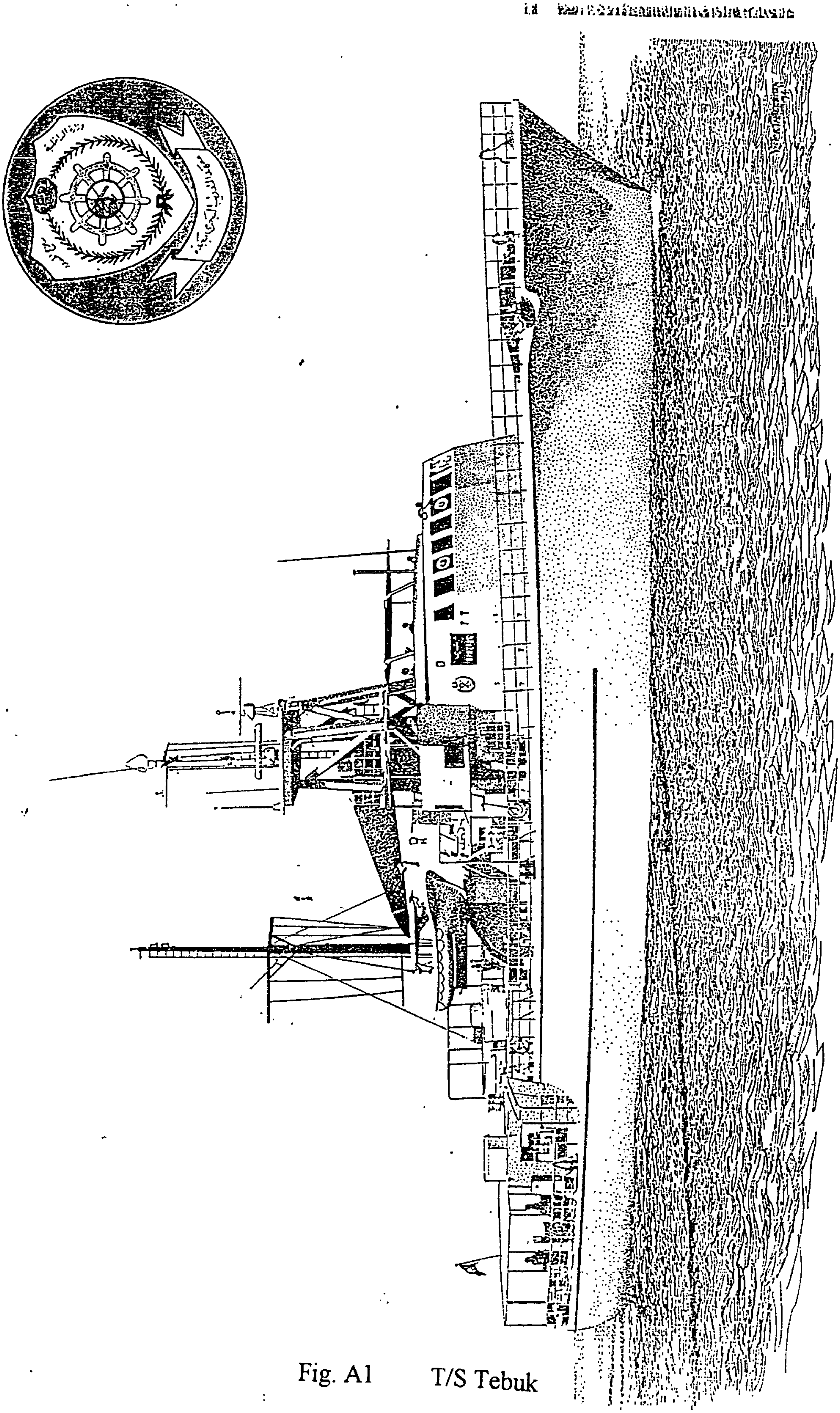

Fig. A1 T/S Tebuk

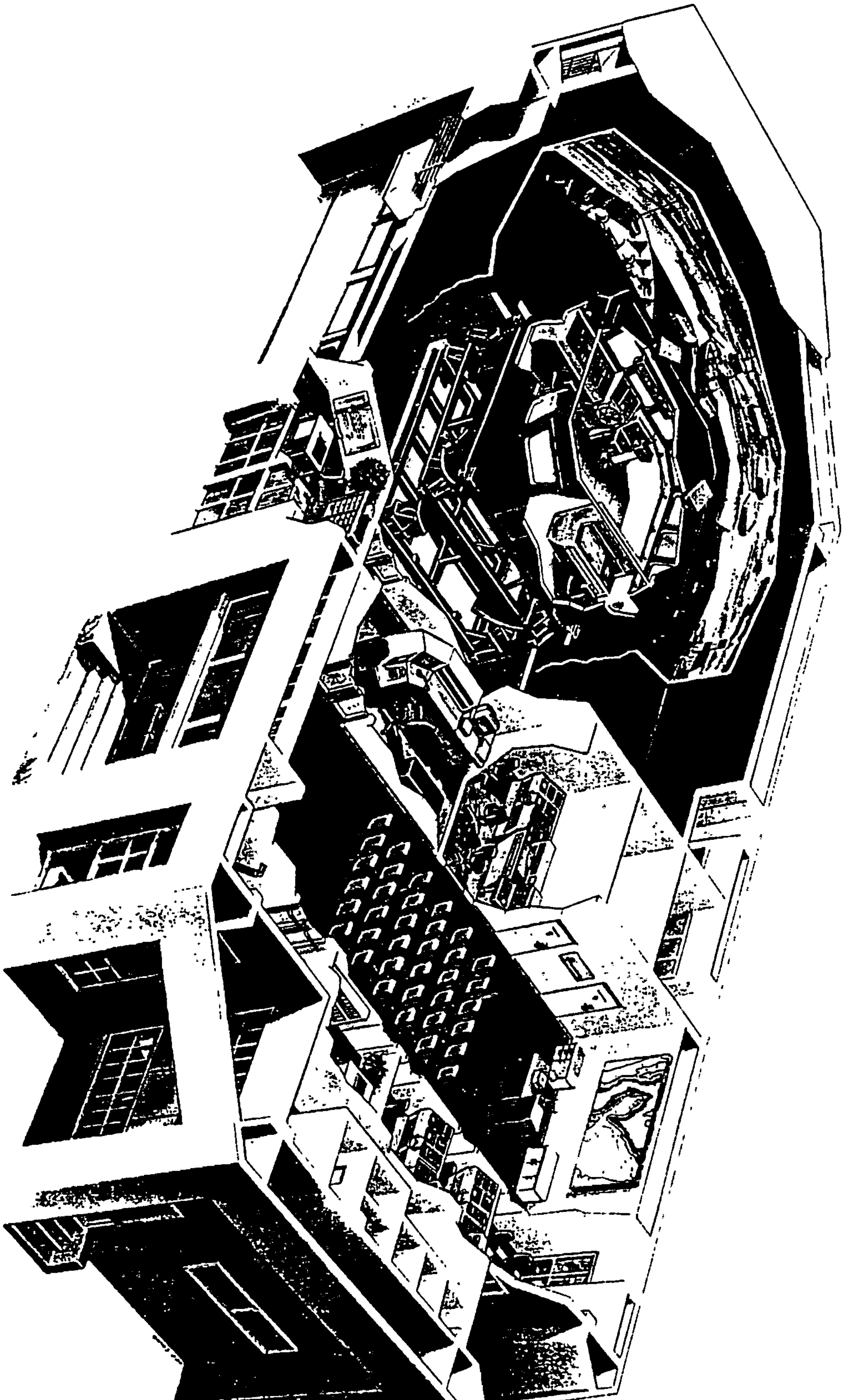

Fig. A2 Overall Layout

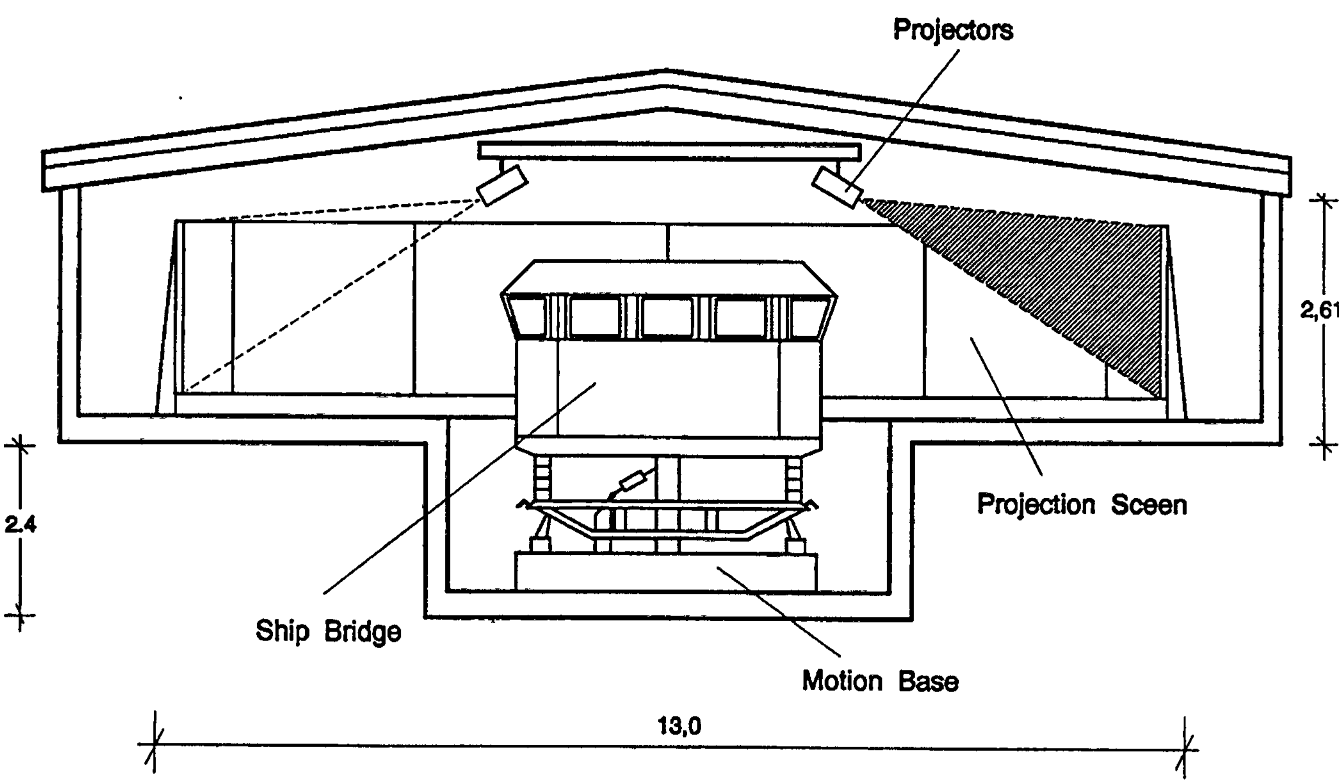

Fig. A3 Simulator Motion

APPENDIX B

Table B1 Estimates of marine simulator types

	Number
Simulators with a visual ship manoeuvring capability	104
Radarand Radar Navigation	375
Engineroom	110
Navigation Instrument	60
Cargo & ballast control	45
Fisheries	30
GMDSS	50
Oil Spill Management Trainer	5
VTS 10 High Speed Craft	2
Riverboat	3
Total	794

Cited from Muirhead, P. (1996) Simulation systems & training methodology. Growth and Development, Lecture notes.

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APPENDIX C

TABLE C1 DEVELOPMENT OF SHIPHANDLING SIMULATORS 1967-1995
(Simulators with a visual capability)

No	Name and location	Year	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 Univ., Japan	1971	CGI	University
5	SS Bremen, W.Germany	1975	Slide project	VFW-Fokker
6	IHI, Tokyo, Japan	1975	CG	IHI/NAC
7	SHS, Osaka Univ., Japan	1975	Shadowgraph	University
8	Navy, DenHelder, Netherlands	1975	Nocturnal	Navy
9	TNO-Soesterberg, Netherlands	1976	Modelboard	TNO
10	CAORF, K.Pt., N.Y., USA	1976	CGI	Sperry
11	Marine Safety Int, N.Y.,USA	1976	Modelboard	Sperry
12	MARIN, Wageningen, N'lands	1976	Nocturnal	TNO
13	Warsash College, UK	1977	Nocturnal	Decca 3
14	TUMM, Tokyo, Japan	1983	CGI	NAC/Uni
15.	Bremen FHS, Germany	1978	Nocturnal	VFW-Fokker
16	Mitsubishi, Nagasaki, Japan	1978	Slide Project.	MHI
17.	Ship Analytics N.Stoni'tonUS	1979	CGI	Ship Analytics
18	SMS Trondheim, Norway	1979	Nocturnal	VFW-Fokker
19	Danish Mar.Inst, Denmark	1980	CGI/TV	DMI
20	Warsash College, UK	1981	Nocturnal	Decca
21	MITAGS, Baltimore, USA	1981	Nocturnal	VFW-Fokker
22	S.Shields College, UK	1982	Nocturnal	Decca
23	CASSIM, UWIST Cardiff	1982	CGI/Tepigen	Marconi/Decca
24	SUSAN, Hamburg, Germany	1982	CGI	Krupp Atlas
25	Shipsim, Glasgow, Scotland	1982	Nocturnal	Decca
26	SMS, Trondheim, Norway	1982	Slide Project.	VFW-Fokker
27.	RSSC, Leningrad, USSR	1983	Nocturnal	Norcontrol
28.	Marin, Wageningen, N'lands	1983	CGIGraphic	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.	TUMM, Kobe ,Japan	1985	CGI	na
33.	Taiwan Maritime College	1985	CGI	Krupp Atlas

Table C1 continued No	Name and Location	Year	Type	Manufacturer
34.	Piney Point, Maryland, USA	1985	CGI	Ship Analytics
35	USCG, N. London, Conn. USA	1985	CGI	ShipAnalytics
36	Finsim, Espoo, Finland	1986	CGI	Racal/Mconi
37	MTC, Ashiya, Japan	1987	CGI	MTC
38	Navy, Kiel, W.Germany	1987	CGI	Krupp Atlas
39	Plymouth Polytechnic, UK	1987	CGI	Racal/Decca
40	Ship.Res.Inst,Tokyo,Japan	1988	CGI	na
41	Korean Mar. T.I. Pusan, Korea	1988	CGI	Norcontrol
42	FETI Vladivostok, Russia	1989	CGI	Norcontrol
43	Petropavlovsk Russia	1989	CGI	Norcontrol
44	Instituto Osservatori Genoa	1989	CGI	Sindel
45	N. Scotia Nautical Inst. Canada	1989	CGI	Norcontrol
46	ENMM St Malo France	1989	CGI	Norcontrol/Thomson
47	Sakhalin Shipping Co Russia	1989	CGI	Norcontrol
48	Chabahar Iran	1989	CGI	Norcontrol
49	Bulgarian MTI, Bulgaria	1990	CGI	Norcontrol
50	Haugesund Mar. Coll, Norway	1990	CGI	Norcontrol
51	NIOC Teheran Iran	1990	CGI	Norcontrol
52	Danube Shipping Co, USSR	1990	CGI	Norcontrol
53	Danish Mar. Inst,,Denmark	1990	CGI	DMI
54	KMTRC Korea	1990	CGI	Ship Analytics
55	Inst.Tec.Nautico, Venezia Ital	1990	CGI	Sindel
56	Kesen Inst.Piraeus, Greece	1990	CGI	Sindel
57	Sakhalin Ship Co, Russia	1991	CGI	Norcontrol
58	State Univ. N.Y.	1992	CGI	Norcontrol
59	Seamans Inst, N.Y., USA	1992	CGI	Norcontrol
60	MSCN Wageningen, N'lands	1992	CGI	MSCN
61	Marine Inst, N'foundland, Can	1992	CGI	Norcontrol
62	Vestfold Poly, Tonsberg, Norw	1992	CGI	Norcontrol
63	World Trade Centre,Singapore	1992	CGI	Norcontrol
64	Indian Navy Bombay	1992	CGI	Ship Analytics
65	Kotha,Finland	1992	CGI	Sindel
66	SMS Trondheim Norway	1992	CGI	Norcontrol
67	Britannia RNC UK	1992	CGI	Norcontrol
68	NAROV, Curacao	1992	CGI	Norcontrol
69	Maine Marit. Academy USA	1992	CGI	Norcontrol
70	Inst.Tecnico Nautico Palermo	1992	CGI	Sindel
71	Kotka Inst. Naut. Studies, Fin.	1992	CGI	Sindel

Table C1 (Con't)

No	Name and Location	Year	Type	Manufacturer
72	Yusen Mar.Sc.Yokyo, Japan	1992	CGI	Yusen
73	Kalmar Mar. Acad., Sweden	1993	CGI	Norcontrol
74	Nizhny Novgorod, Russia	1993	CGI	Norcontrol
75	Far Eastern T.I. Vladivostok	1993	CGI	Norcontrol
76	Mariehamn, Finland	1993	CGI	Norcontrol
77	STC Sydney, Australia	1993	CGI	Norcontrol
78	Port of Singapore, Singapore	1993	CGI	BA/Ship Analy
79	State Uni.St Petersburg Russia	1993	CGI	Sindel
80	Southampton Institute, UK	1993	CGI	Norcontrol
81	W.Japan Dyn. Inst. Sasebo	1993	CGI	na
82	Star Centre Dania,Florida USA	1993	CGI	Norcontrol
83	MSTC Terschelling, N'lands	1993	CGI	MSCN
84	SMS Trondheim, Norway	1993	CGI	Norcontrol
85	FMSS Navy, Brazil	1993	CGI	Ship Analytics
86	Panama Canal Commission	1993	CGI	Ship Analytics
87	Tromso College Norway	1993	CGI	Norcontrol
88	STAR Toledo, Ohio USA	1993	CGI	Norcontrol
89	WSM Szczecin Poland	1994	CGI	Norconrtol
90	PDV Marine Venezuela	1994	CGI	Norcontrol
91	MSR Rotterdam	1994	CGI	MST
92	Turkish Navy	1994	CGI	Norcontrol
93	HMS Dryad Portsmouth UK	1994	CGI	Norcontrol
94	West Coast STAR Washington	1994	CGI	Norcontrol
95	US Navy, San Diego USA	1994	CGI	MST
96	Bombay, India	1994	CGI	Ishikawajimi HI
97	RT.Navy, Thailand	1994	CGI	Atlas Electronic
98	Volgo Tanker Company Russia	1994	CGI	Norcontrol
99	CCG,Sydney NS,Canada	1994	CGI	Norcontrol
100	Danish Mar.Inst, Denmark	1994	CGI	Norcontrol
101	RNN, Den Helder,Netherlands	1994	CGI	Norcontrol
102	Singapore Water Police	1994	CGI	MSCN
103	Gijon, Spain	1995	CGI	Ship Analytics
104	AMTA Alexandria, Egypt	1995	CGI	Ship Analytics

Source : Muirhead, P.M. Simulation System and Training Methodology. Lecture notes, WMU.