1994

An evaluation of engine room simulation for engineering training in Mauritius

Marday Armoogum Moorghen

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AN EVALUATION OF ENGINE ROOM SIMULATION FOR ENGINEERING TRAINING IN MAURITIUS

BY

MOORGHEN MARDAY ARMOOGUM

Republic of Mauritius

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

MASTER OF SCIENCE

in

MARITIME EDUCATION AND TRAINING
(Marine Engineering)

Year of Graduation
1994
I certify that all material in this dissertation which is not my own work has
been identified and that no material is included for which a degree has been
previously conferred upon me.

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

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© 1994, Moorghen, M.A.
Dedicated to
my late father
Mardagmootoo Moorghen
and
my mother
Atchi Moorghen
I would like to express my sincere gratitude and appreciation to Prof. Kenji Ishida, my Course Professor and Supervisor who has given me the support and skilful guidance in preparing this dissertation.

My most heartfelt thanks to Prof. Peter Muirhead for his occasional words of advice and encouragement.

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Finally, and most important of all, I hereby acknowledge my indebtedness to my parents, brother, sister, other relatives and friends for their unyielding support through fervent prayers in making my stay away from home more bearable.
ABSTRACT

The thesis is a study of the engine room simulator (ERS) as a training device comparing with traditional methods used for assessing competence and skills of marine engineers.

The present maritime education and training system in the Mauritian context is discussed. The prevailing shortcomings and future remedial measures are considered.

A brief look is taken at the present methods available to evaluate competence in the marine field. The future trends in maritime education and training are considered taking into account manning and technological changes that are taking place. The growth and development of engine room simulators as training and assessment tools are outlined. Simulation training philosophies and programmes developed by a number of maritime nations are explored. The importance and advantages of the medium are highlighted.

With a view to improving maritime training in Mauritius, a structure of an engine room simulator training programme is proposed with important considerations in developing, implementing and evaluating the programme pointed out.

In the final chapter, keeping in view the benefits of simulators, a number of recommendations are made to implement new marine engineering schemes incorporated with engine room simulator programmes to train marine engineer officers in Mauritius.
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARPA</td>
<td>Automatic Radar Plotting Aids</td>
</tr>
<tr>
<td>CRT</td>
<td>Cathode Ray Tube</td>
</tr>
<tr>
<td>DANIDA</td>
<td>Danish International Development Agency</td>
</tr>
<tr>
<td>ERS</td>
<td>Engine Room Simulator</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GMDSS</td>
<td>General Maritime Distress and Safety System</td>
</tr>
<tr>
<td>ILO</td>
<td>International Labour Organisation</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organisation</td>
</tr>
<tr>
<td>ISF</td>
<td>International Shipping Federation</td>
</tr>
<tr>
<td>MCR</td>
<td>Maximum Continuous Rating</td>
</tr>
<tr>
<td>MDFV</td>
<td>Motor Driven Fishing Vessel</td>
</tr>
<tr>
<td>MET</td>
<td>Maritime Education and Training</td>
</tr>
<tr>
<td>MSTS</td>
<td>Mauritius Sea Training School</td>
</tr>
<tr>
<td>PID</td>
<td>Proportional Integral Differential</td>
</tr>
<tr>
<td>SOLAS</td>
<td>Safety of Life at Sea</td>
</tr>
<tr>
<td>STCW</td>
<td>Standard of Training, Certification and Watch keeping for Seafarers</td>
</tr>
<tr>
<td>TEU</td>
<td>Twenty Equivalent Unit</td>
</tr>
</tbody>
</table>
BACKGROUND TO THE PROBLEM

A number of recent spectacular accidents, such as, "Torrey Canyon", "Amoco Cadiz", "Exxon Valdez", "Ever Level", "Agean Sea", "Braer", "Nagasaki Spirit", "Ian Herveliusz", has drawn the attention of mankind on the inherent risks of ship operation.

All these most spectacular accidents are claimed to occur because of operational problems which in turn give rise to ecological and economic disasters. Over a period of 10 years, from an average of 374 total annual losses, 205 and 169 losses had been due to technical and nautical reasons respectively. A detailed analysis of the above mentioned accidents may be evaluated, weighed and synthesised into educational and training programmes. This study deals with simulators as a training aid to improve safe ship's operation and to increase in an effective way engine room handling, thus promoting safety of life at sea and cleaner oceans.

In former days, young men entered their career life at the age of 12 to 14 and worked their way up through the stages of Able-bodied seaman, bosun and so on, until they eventually left for a short, shored-based educational period. Having qualified for an officer's certificate they come back onboard for at least two or three years applying the knowledge gained so far in their first appointments as junior officers and collecting again practical feedback to it
before they passed a second short term in a shore-based institution to upgrade their qualification.

The introduction of automation has changed the Maritime Education and Training world. Use of simulators has increased and compensates a diminution in practical seagoing experience.

In addition the following facts prevail:

1. crew sizes have reached an absolute minimum of six (6)
2. ship size and speed have stabilised on a high level
3. harbour turnrounds are counted by hours rather than by days.
4. new super high-speed small ships are emerging for special cargoes and trade routes.
5. the technological differences in available ships has increased.

Consequently, simulators are needed in order to prepare the small community of the remaining seafarers for the wide range of technical systems and problems they encounter during their professional life.

PURPOSE OF THE STUDY

The International Maritime Organisation (IMO) has already embarked to revise the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW 1978 Convention) which is to be completed by July 1995. In line with this revision, it is the purpose of this
study to highlight the importance and benefits of simulator training in enhancing the education and training of marine engineers.

However, it may be stated that simulator training will never fully replace seagoing experience. But simulators can contribute to improve training standards. To some degree they may provide or rather replace some of the practical seagoing experience. The simulator training concept caters for the entire education and training required from entry to the highest seagoing qualification.

METHODOLOGY OF THE STUDY

The methodology used for this study was undertaken by a literature review of information gathered from conference papers, lectures at the University and seminars. Moreover, many major sources of information were from direct observations and discussions made during field studies to a number of maritime institutions.

Finally, the information and data were analysed to formulate the recommendations.

SCOPE AND LIMITATION OF THE STUDY

Chapter I describes the importance of shipping in Mauritius giving some basic facts about Mauritius, its economy and port.
Chapter II examines the present Maritime Education and Training (MET) in place in Mauritius. The present shortcomings and future training policy are also discussed.

Chapter III gives an overview of the changing world of Maritime Education and Training, exploring the various methods of training available. The future trends of maritime education and training are also discussed.

Chapter IV examines the growth and development of simulators. Simulator training programmes of some developing countries are also explored and compared.

In Chapter V, the approach and important aspects of developing simulator training programmes are discussed. The objectives, scope and methodology of simulator training are also outlined. A proposed planned simulator programme for marine engineer officers is given.

Chapter VI covers the assessment and validation of the simulator training programmes. Various methods of evaluation are considered.

Chapter VII conveys the conclusion of the study with recommendations on the use of engine room simulator as a training device.
CHAPTER I

THE ROLE OF SHIPPING IN MAURITIUS

1.1 MAURITIUS IN BRIEF

An ex-British colony, the island nation with a land area of 1,865 sq Km, of some 1,200,000 inhabitants lies 2414 Km south of the equator in the Indian Ocean. Mauritius is a multiracial country. The largest single group (about 52 %) of the population are Indian Hindus, then there are Indian Muslims (17 %), the Creoles who are of mixed European and African background (25 %), and the rest, mainly of French and Chinese descent.

The official language is English but many languages are spoken. The language patterns relate more to history than to the current presence of a handful of Brits on the island. The British took the island from Napoleon in 1810 to protect its India merchantmen from his Mauritius-based privateers. A little later, after the congress of Vienna had awarded the island to the United Kingdom, it is decided to introduce English as the official language of the government and the schools, but left French in place as the dominant language of commerce, along with Creole, a French-based pidgin.
Today, English remains the official language, but the newspapers and other media are largely in French, and nearly everyone speaks creole as well as another language or two. Some of the Indians speak hindi, the dominant language of the subcontinent, while more speak Bhojpuri, another tongue.

The main sources of income are from export of sugar, textile products and tourism. According to North (1993), for the first time, in 1993, the value added by manufacturing on the island - some 5.5 billion rupees (the nation's currency) passed the value of the sugar crop, 5.0 billion rupees. And, the per capita income has kept climbing, US$ 3000 a year in 1993.

1.2 SHIPPING IN THE DEVELOPMENT OF MAURITIUS

Mauritius, with a highly open economy, has over the years developed a long tradition of International Trade. With reference to Seebaluck (1993), in 1991, Imports and Exports represented seventy percent (70%) and fifty-five percent (55%) of the Gross Domestic Product (GDP) respectively. Considering the geographical location of Mauritius, its size, its very limited natural resources and the extiguity of its domestic market, has an additional importance as far as International Trade is concerned. It is a mere fact, trade has been the engine of economic growth of Mauritius.

Maritime Transport has been of key importance all throughout the history of Mauritius. As the most efficient means to ensure trade and development, it is still today, and it is likely to continue to be so perpetually. In the past few years, many cargo planes were registered to land at our international airport, Sir Seewoosagur Ramgoolam (SSR) airport, however, the fact remains that yearly ninety-nine percent (99%) of our External Trade solely depends on
shipping services. As a matter of fact in 1991, the sea cargo traffic accounted to over three (3) million tons while Air freight accounted only to about twenty-nine (29) thousand tons.

The quality and costs of shipping services contributes to a large extent to the development, and as a result, to the growth of the economy. The guarantee of a reliable shipping service at a reasonable price offered to Importers and Exporters is a determining factor, it helps expand external trade.

For Mauritius, these issues have a special significance as considerable time, money and efforts are being put into Investment and Export promotion. In the overall costs of production, transportation cost is generally an important element and to the extent transportation cost can be lowered and the efficiency of transport improved, overall costs of production can be reduced and production increased.

1.2.1 PILLARS OF SHIPPING SERVICES

The three pillars of shipping services are:

(a) CONTINUITY

The assurance of the availability of shipping space from one region to another over a given period of time promotes trade development. If there is a high risk that shipping services would be stopped after a short period of time, no investment will be made by anybody in such a venture.
(b) FREQUENCY

Having ascertained the continuity of services, the next factor, the trader looks into, is the frequency of services. Generally, the frequency of shipping is a contributing element in the whole organisation of a company. For example, information of exact dates of ship movements helps in the management of inventories and consequently reducing costs. Similarly, with regular services, the company is able to maintain as low as possible interests and other charges incurred in pre and post shipment finance. Basically, the frequency of shipping services helps the company tremendously to remain competitive and to retain its overseas markets.

(c) SHIPPING COSTS

If freight charges are too high, overseas buyers may go for other sources of supply. The trader is also influenced by the freight factor in choosing his sources of raw material and his market.

In addition, foreign investors wanting to invest in Mauritius in order to take advantage of the package of incentives offered by the Government might be deterred if the benefits are outweighed by higher freight charges. To promote foreign trade, shipping is often look as an ancillary service by many governments worldwide. However, shipping should also be viewed as a commercial enterprise struggling in a competitive environment.
1.2.2 FACTORS TO SUPPORT SHIPPING SERVICES

The government has already embarked with the effort to support the shipping services. In this connection, a series of measures has been taken, such as placed below:

a) the proclamation in 1991 of the Mauritius Merchant Shipping Act 1986 as amended thereafter to provide an efficient legal framework for our maritime industry in accordance with the present situation and to make it possible for foreigners to register their ships in Mauritius,

b) the creation of a Directorate of Shipping to better regulate shipping activities,

c) the organisation of an appropriate Training Course at the Mauritius Sea Training School (MSTS) for those opting for a career at sea,

d) the establishment of the Mauritius Shipping Corporation to spearhead development in the shipping sector,

e) the income derived by the registered owner of a vessel registered in Mauritius, provided the income is derived from any trade (excluding fishing) carried out Mauritius territorial waters is exempted from tax,

f) ship stores, consumables, spare parts and bunkers are exempted from customs and excise duties,
g) income derived by the Mauritian seafarers working on foreign going vessels is tax exempted.

1.3 BASIC FACTS ABOUT THE PORT

Refering to Rissik (1994), the container throughput is in line with both the world trend and also the fast industrialising Mauritian economy. Over the last past five years, the container throughput has more than doubled to an expected 90,000 teu in 1994. The estimated future traffic growth is at some 5% to 6% per annum.

With the establishment of freeport concept, it is believed that there could be an added increase in new traffic, especially from the other Indian Ocean Islands. Due to the expected increase in traffic flow, a new terminal has already been planned to accommodate between 200,000 and 250,000 teu per annum.

Under the normal growth pattern this should suffice Mauritius until the year 2020. Some 300 hectares of reclaimed land have already been earmarked for future development projects, freeport development and other port-based industries. The port handles some 600 cargo vessels a year and an addtion of 400 fishing fleet calls. Container throughput is growing steadily with a distinct bias in favour of containerised cargo and the overall throughput has reached 3.4 million tons. The initial port upgrade programme, including deepwater quays, sheds, a container park and new equipment, was completed in the 1980s to coinside with the country's economic growth. However, concious of its key role in the future of the country's industrial development, the port has to be further improved to meet the continuous trade increase. A
natural and well protected, albeit small port, Port-Louis harbour is the
country's only maritime gateway to the rest of the world.

The more the country prospers, the more the volume of Imports and Exports
will expand. And Maritime Transport will be expected to play a very vital role
to sustain the process of development. In fact the standard of living and the
quality of life of the Mauritians depend heavily on an efficient shipping
service.
CHAPTER II

PRESENT MARITIME TRAINING IN MAURITIUS

2.1 BACKGROUND

The Mauritius Sea Training School operating under the aegis of the Ministry of Trade and Shipping is responsible for implementing seafarers' training programmes. The school was established in 1970 with the assistance of the Danish Government through the Danish International Development Agency (DANIDA) on basis of a feasibility study undertaken in the same year by the International Labour Organisation (ILO).

The school was originally established as a pilot project to provide pre-sea training for young school leavers who wished to make a career at sea. The facilities at the school were subsequently expanded and presently training is being provided for all categories of ratings and deck officers of fishing vessels.

The following courses are being offered at the school:
1) A 20-week pre-sea training course for school leavers of between 16 and 20 years of age to make them suitable for jobs as deck and engine room hands.

2) A 10-week retraining course for those who have already some sea-going experience on deck or in the engine room and are not more than 45 years of age.

3) A 6-month pre-sea navigating cadet course for those with higher school certificate or general certificate of education (Advanced level).

4) A 2-week Able bodied seaman and efficient Deck Hand Course for serving seaman.

5) A 24-week course for second officers and skippers of fishing vessels.

**TABLE 2.1 No. of Trainees Trained at the MSTS**

<table>
<thead>
<tr>
<th>COURSES</th>
<th>NO. OF TRAINEES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-sea</td>
<td>1110</td>
</tr>
<tr>
<td>Retraining</td>
<td>30</td>
</tr>
<tr>
<td>Second-hand</td>
<td>60</td>
</tr>
<tr>
<td>Skipper</td>
<td>40</td>
</tr>
<tr>
<td>Motorman</td>
<td>60</td>
</tr>
<tr>
<td>Junior Engineer (fishing vessels)</td>
<td>30</td>
</tr>
</tbody>
</table>

( About 1550 seaman, excluding Basic Seamanship Course for catering officers, have been trained since its inception in 1970)
NOTE: Courses for Motorman and Junior Engineer (fishing vessels) have been offered since 1993.

2.2 LACUNAE IN ENGINEERING TRAINING

One of the primary tasks undertaken by the Marine Engineering Expert provided under the Indian Technical Economic Co-operation Programme, was to evaluate the facilities available at MSTS with a view to introduce marine engineering courses. The details of facilities available at Sea Training School are listed at Appendix I for reference and information. The school is equipped with basic facilities and materials for conventional seamanship, life-saving and survival training. However, the evaluation had revealed that facilities available at the school are inadequate for conducting marine engineering training courses and the salient shortcomings observed are mentioned below:

a) lack of qualified engineering instructors,
b) lack of adequate workshop facilities,
c) lack of practical training facilities on marine engineering equipment,
d) insufficient training aids such as wall charts, diagrams, video training films and textbooks,
e) lack of standardized curriculum,
f) nil lesson plans.

Further, it is also observed that introductory pre-sea (engineering) training course that is being offered at this school has the following limitations:
a) the content of the course is not in accordance with stipulations made by IMO.
b) the curriculum of the course is not aimed to impart knowledge in marine engineering subjects.
c) this could only help qualified candidates to join as untrained engine room ratings

2.3 NEED FOR MARITIME TRAINING

Training of seaman has recently been greatly influenced interalia by three major factors, viz the ratification of the STCW 1978 Convention by the Government, Mauritius open registry project and the expanding nature of our Maritime Sector. It is worthwhile giving a brief idea of these factors.

(i) The Government ratified the STCW 1978 Convention in 1991. The convention requires member states to undertake training of their seafarers and marine officers as per the standards set out in the Convention. The principal objective of the Convention is to improve the training of marine personnel serving onboard ships.

(ii) The open ship registry project which is also one of the offshore business activities gives opportunity to shipowners on a worldwide basis to register ships in Mauritius and fly the Mauritius flag. The project will most likely among other things create employment, generate foreign exchange earnings and foster development of ancillary services like insurance and banking.
(iii) Originally Mauritius had a relatively small Maritime Sector with a few ships. Over the years the fleet has gradually expanded and now consists of 15 cargo ships, 24 fishing vessels and 13 pleasure yachts. The fleet is expected to increase further with sustained economic development and the promotion of the Mauritius Ship Registry. Table 2.2 summarizes the number of ships in the Maritime Sector.

<table>
<thead>
<tr>
<th>SERIAL NO.</th>
<th>TYPES OF SHIPS</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cargo Ships</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>Fishing Vessels</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>Pleasure Yachts</td>
<td>13</td>
</tr>
</tbody>
</table>


A survey of the manpower resources in the local Maritime Sector has revealed a disequilibrium in the supply and demand of maritime personnel. There is a scarcity of both deck and engineering personnel and this scenario has necessitated the initiation and implementation of comprehensive maritime training programmes. At present an acute manpower disequilibrium prevails not only locally but also on an international scale. A recent report issued by the International Shipping Federation (ISF) concluded that an average of 40,000 ship officers will be required in each of the next 10 years to ensure a supply and demand equilibrium in the year 2000.
2.4 NEW MARINE ENGINEERING TRAINING POLICY

Due to lack of suitable marine engineering training schemes in Mauritius, most of the engineering personnel employed onboard ships, especially fishing vessels, do not possess training and qualifications in accordance with IMO's STCW 1978 Convention. In the long term, non-availability of qualified manpower is detrimental to safety of life and equipment at sea.

In view of the constraints mentioned above, generation of qualified engine room personnel for local shipping industry is an immediate necessity. Therefore, recommendation of a comprehensive training policy would have to be evolved to introduce new marine engineering training schemes at the MSTS. The formulation of this policy would have to take into consideration factors such as design and implementation of courses as per IMO standards, creation of necessary infrastructural facilities, enforcement of qualification standards for employing various categories of engine room personnel as per the Merchant Shipping Act and seeking cooperation of vessel owners to enforce new qualification standards. In pursuance of this, a series of action plans have to be adopted for introducing new marine engineering training schemes. The following activities have been identified as essential to achieve the above task:

a) To identify suitable external lecturers for employment on part-time basis for teaching marine engineering subjects such as lubrication oil technology, marine electrotechnology and maintenance due to lack of trained marine engineering instructional staff at the school.

b) To design curriculum of courses as per IMO standards.
c) To introduce new courses in a phased manner. During first phase, to conduct courses suitable for engine room personnel of fishing vessels.
d) To procure necessary training aids.
e) To impress upon vessel owners on the objectives of proposed training programmes.
f) To project requirement of budgetary support for implementation of new training schemes.

2.5 TRAINING ASSISTANCE FROM EXTERNAL ORGANISATIONS

Training facilities available with the organisations below were sought due to lack of proper infrastructural facilities and adequately qualified instructional staff. The following organisations have been identified as suitable for rendering training assistance.

a) Professor Upadhyaya Training Institute, Piton for theoretical and practical training in engineering subjects, i.e., workshop technology, diesel engines, engineering drawing, and refrigeration and airconditioning.
b) Central Electricity Board and Mauritius Marine Authority for practical training on diesel engines.
c) Mauritius Marine Authority for assistance to impart theoretical instructions in marine engineering subjects.
d) ST. John Ambulance division for training in first aid.
e) Fire Fighting organisation, Curepipe for imparting practical and theoretical training in fire fighting.
2.6 MASTER PLAN - TRAINING OF ENGINE ROOM PERSONNEL OF FISHING VESSELS

A plan has been prepared to introduce new marine engineering courses at the MSTS, tailored to meet training requirements of engine room personnel of fishing vessels. The plan has been submitted to the Ministry of Trade and Shipping for perusal and implementation.

This plan, while preparation has taken into consideration the factors such as organisation structure of engine department of a fishing vessel, standards stipulated in IMO's STCW 1978 Convention, qualification requirements stipulated in Merchant Shipping Act and the availability of training facilities.

This plan employed a two pronged approach. The first involves introducing new training courses with an aim to upgrade skills of untrained and unqualified personnel employed onboard fishing vessels. The curriculum does not conform to the standards stipulated in STCW 1978 Convention. Since most of the marine engineering personnel currently holding employment on board fishing vessels lack minimum academic qualifications and formal professional training, it is not feasible for this category of personnel to go through standard curriculum designed on the basis of the STCW 1978 Convention. The second approach is to introduce courses to generate personnel to pursue both these approaches concurrently, to introduce trained manpower onboard fishing vessels in gradual manner without affecting working of this industry. The salient aspects of this plan are detailed below:
a) Design of a Motorman course, 24 weeks duration, to train engine room ratings in accordance with Regulation III/6 of STCW convention.

b) Design of a Basic Engineers Course (24 weeks duration) and an Advanced Engineers Course (24 weeks duration) to upgrade skills of untrained Second Engineers and Chief Engineers currently employed onboard fishing vessels.

c) Design of a Junior Engineers Course (24 weeks duration), a Second engineers Course (48 weeks duration) and a Chief Engineers Course (24 weeks duration) to train and achieve qualifications of engineer officers in accordance with Regulation III/5 of STCW 1978 Convention at the end of these courses.

d) Development of curriculum for all above mentioned courses.

e) Identification of infrastructural facilities to implement above courses.

f) Requirement of entry qualifications and mode of examinations have been incorporated in the plan.

Tables 2.3 and 2.4 which follow, exhibit details of Deck and Marine Engineering Courses.
<table>
<thead>
<tr>
<th>SERIAL NO.</th>
<th>TRAINING COURSES</th>
<th>ENTRY REQMTS</th>
<th>COURSE PER YEAR</th>
<th>COURSE DURATION</th>
<th>COURSE INTAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pre-Sea Course</td>
<td>S:C Level or GCE/GCE ‘A’Level with Maths and Physics</td>
<td>1</td>
<td>5 months</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Retraining Course</td>
<td>Serving Seaman</td>
<td>1</td>
<td>10 weeks</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Basic Seamanship (catering)</td>
<td>Serving Seaman and S:C Holders</td>
<td>2</td>
<td>2 weeks</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Second-Hand Course (fishing vessels)</td>
<td>4 years at sea or 2 years at deck capacity</td>
<td>1</td>
<td>3 months</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>Skipper Course</td>
<td>Holders of Second Hand Certificate</td>
<td>1</td>
<td>3 months</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2.4 Marine Engineering Courses

<table>
<thead>
<tr>
<th>SERIAL NO.</th>
<th>TRAINING COURSES</th>
<th>ENTRY REQMTS</th>
<th>COURSE PER YEAR</th>
<th>COURSE DURATION</th>
<th>COURSE INTAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Junior Engineer Course</td>
<td>S.C Holders with Maths and Physics</td>
<td>1</td>
<td>6 months</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Existing motormen or S.C Holders/ Equivalent</td>
<td>1</td>
<td>6 months</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Basic Engineering Course</td>
<td>Acting Second and Chief Engineers of Fishing Vessels</td>
<td>1</td>
<td>6 months</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>Advanced Engineering Course</td>
<td>Acting Chief Engineers of Fishing Vessels</td>
<td>1</td>
<td>6 months</td>
<td>15</td>
</tr>
</tbody>
</table>

2.7 SETTING UP OF A NEW MARITIME INSTITUTE

The Ministry of Trade and Shipping in collaboration with the Mauritius Marine Authority has embarked on a project to establish a new maritime institute. In addition to the courses mentioned earlier, the newly constructed training institute will cater for the training of Port workers, officers and mates of cargo vessels. It is also envisaged to start a Diploma Course in Marine Engineering to enable recipients of the course to take up employment as junior or cadet engineer on board merchant ships. A variety of adhoc courses will also be organised to satisfy the specific needs of certain organisations. The courses will comprise of the following:

- Survival at sea
- Maritime Search and Rescue
- Vessel Traffic Surveillance
- General Maritime Distress and Safety System (GMDSS)
- Fire Fighting
- Hazardous Cargo Handling

Training in fishing manoeuvres and Master Fisherman Course will also be considered.

The total estimated cost of the project is ten (10) million mauritian rupees.
CHAPTER III

THE CHANGING WORLD OF MARITIME
EDUCATION AND TRAINING

Education and training in the maritime sphere is conducted within vastly different infrastructures, varied institutional frameworks and course programmes using a variety of standards in equipment and staff capability. Some countries utilise front-ended training schemes, others sand-witched programmes. Institutions may be established as vocational training centres, technical or secondary colleges, or tertiary polytechnics or universities. The management of Maritime Education and Training may be within a monotechnic institution or be a small department within a large polytechnic. Courses for officers may be made through traditional certificate of competency programmes, or be part of an accredited educational award.

3.1 TRAINING, LEARNING, EDUCATION AND DEVELOPMENT

Before examining how training is initiated and then organised it is necessary at this stage to define what is meant by training and to distinguish it from the closely related concepts of learning, education and development. From the
Department of Employment "Glossary of Training Terms" (1978, 2nd Edition); the definitions are as follows:

TRAINING

A planned and systematic effort to modify or develop knowledge/skill/attitude through learning experience, to achieve effective performance in an activity or range of activities. Its purpose, in the work situation, is to enable an individual to acquire abilities in order that he or she can perform adequately a given task or job.

LEARNING

The process whereby individuals acquire knowledge, skills and attitudes through experience, reflection, study or instruction.

EDUCATION

A process and a series of activities which can aim at enabling an individual to assimilate and develop knowledge, skills, values and understanding that are not simply related to a narrow field of activity but allow a broad range of problems to be defined, analysed and solved.

DEVELOPMENT

The general enhancement and growth of an individual's skills and abilities through unconscious learning.
3.2 MET SYSTEMS

The fundamental mechanisms for ensuring proper and adequate Education and Training of Seafarers are the Maritime Education and Training Institutions. However, there are at present various differences in the "systems" (methodologies), as well as alleged qualitative deficiencies in some cases. Accordingly, there is a clear need to harmonize to the maximum extent possible the MET systems, especially that MET institutions are also best equipped for managing and conducting the examinations for seafarers. Obviously any effort towards ensuring adequacy and harmonization of systems for the competence and certification of officers and key ratings has to take fully into account the quality of the education and training of all ratings deserve attention along with the implications of the different manning structures and patterns that are proposed.

There are two main systems in existence in various countries/regions

These are:

a) A step-by-step system of maritime training and examination commencing with pre-sea training after requisite sea-service at the prescribe appropriate level/s and prior to the examination for each grade of certificate.

The advantage claimed for this system is that theoretical studies, training and practical experience are well timed and harmonized. On the other hand the
disadvantage can be the difficulty in linking this maritime training system to an academic system.

b) A system whereby the full range of studies is covered over a substantially long period at the pre-sea stage itself along with attendant examinations.

In this system the higher levels of certificate depend primarily on acquisition of subsequent sea-service at the different prescribe levels.

The advantage claimed for this system are:

1) the ability to link this to an academic system, and
2) the convenience of organising one single but long course, as against different courses for different levels.

3.2.1 THE MONOVALENT AND POLYVALENT CONCEPT

The two systems; namely, the sand-wiched and front-ended types programmes described above are based on a clear distinction between the programmes of the deck and engine departments. For both departments, the officers undergo totally separate education and training programmes to suit different roles onboard. Such programmes under which officers are educated and trained is called the monovalent training concept.

The polyvalent training or dual purpose training has a history of some 25 years. It has been developed in a number of countries in various ways. The
main countries practising a dual purpose training scheme are France, Germany, Japan, Netherlands, United Kingdom and United States of America. The reasons for developing such a system range from more flexible manning systems to more efficient shipboard operations for the shipping companies and from more job satisfaction to more shore opportunities for the seafarers.

In this scheme the prospective seafarer is trained in both nautical and engineering disciplines. The level and extent of training in both disciplines varies from country to country. Furthermore, there are fully integrated as well as partially or semi-integrated dual purpose systems.

The trainee then, going onboard ship, will practice his skills in both areas simultaneously, or alternatively depending on the way shipboard operations have been structured.

The advantages claimed by the polyvalent officers programme are:

1. it provides greater mobility to all ship officers in the maritime labour market ashore;

2. it instills higher confidence for the Master who could fully understand engine room problems;

3. shipowners have the possibility of reducing crew costs by operating with less officers and keeping less officers on stand-by. Watchkeeping officers have the flexibility of assuming either roles on deck or in the engine room;
4. Officers with a wider understanding of the ship could give the higher level of co-operation between bridge and engine room needed onboard modern ship.

3.3 COMPETENCY BASED TRAINING

There are many areas of skills in which today's seafarers need to be proficient. Ship's equipment has become more technologically advanced, the number of crew members has declined and commercial pressures have increased, but the sea itself has not changed. The operating environment for masters, engineers and watchkeepers is the same as it always was: dangerous and unpredictable.

Early seafarers acquired their competence by learning on the job. It is a traditional way to issue, "certificate of competency" to a successful candidate in the examinations for ship's officers implying that the recipient possesses the necessary competence but that competence has not actually been tested. Knowledge is being tested in the examination, but not the ability to perform a task; the skills necessary to be competent have been largely omitted from the assessment.

There is a critical need, which is not being adequately met, to provide truly relevant training to meet the needs of the shipping industry workplace, training based on an analysis of what a job actually entails and the competencies that are required to do the job. Recognition must, however, continue to be given to the gap between being able to do something (the focus of competency development and assessment) and actually doing it routinely. The gap is closed by experience.
There are two major components involved, competency and assessment of that competency:

1. Competency standards which provide the basis for, and the focus of, shipping industry employment related training. Competency standards set the level of performance required in the workplace. Associated training provides the process whereby one learns how to do the job. The practice develops task organisation skills. The appropriate workplace role develops teamwork and the ability to respond to the unexpected - in other words, overall competency.

2. Performance assessment after seafarers have been trained on the job, the purpose being principally:

- trainee satisfaction as to competence,
- employer satisfaction that investment in training has produced the desired level of performance, and
- feedback on training quality.

Performance assessment is a form of quality assessment. It will show if the training has been successful and, if not, where additional training is necessary.

Whereas much of the training can be effectively done in shore-based training institutions, competency should be either assessed in the workplace - onboard the ship at sea - or in a realistic simulation of the workplace.
3.4 COMPUTER AIDED INSTRUCTION

Computer aided instructions may be a useful method, a means, to bridge the growing discrepancy between the knowledge and skills acquired through earlier education, training and experience and the knowledge, skills and possibly experience required to fit specific requirements providing information material tailored to the actual onboard situation is made available.

3.4.1 THE COMPUTER AS ON BOARD TRAINING TOOL

3.4.1.1 OPERATIONAL INFORMATION

In a shipboard organisation based on a very limited crew size each crew member has a dedicated package of tasks for which he is responsible. Each member has to exactly know under what conditions when and how he has to perform his tasks and while going about his tasks to be aware of the safety aspects; his personal safety as well as the safety of operation and the ship's safety since the majority of tasks will have to be carried out without supervisory control. This holds already for normal operating conditions but is extremely important in case of emergency - or very critical situations.

Since each crew member relies on the safe performance of the other team members it is essential that each crew member has acquired this knowledge and the information should be available in a ready and easy accessible and instructive way so that he can work himself into his function when stationed onboard without intervention of other crew members. This information thereto should be tailored to function. A computer based information source could
fulfil this requirement provided the system is fed with the information in the form of courseware structured for that purpose and that the seafarer is given enough time to utilize the system.

3.4.1.2 NON OPERATIONAL INFORMATION

The seafarers at sea, wishing to widen his field of knowledge compared to landlubbers is at a disadvantage.

The landlubber is in a position to follow various paths to upgrade his knowledge. The only means available to the seafarer is a correspondence course. Many a seaman started out to upgrade his knowledge this way but only a few succeeded in reaching the ultimate goal.

The reason for that being the fact that the onboard situation is not the most favourable situation for study and the fact that due to irregularity in the feedback from the tutorial institute the student is not able to study according to a regular scheme. The improved quality of radio communications might help to overcome this disadvantage partly but the availability of subjected courseware modules including test and finals certainly would provide the seafarer with the opportunity to extend his knowledge or to prepare himself for examinations to obtain either a specific certificate or to qualify for higher ranks.

Thus it can be concluded that the use of a computer based system for information and knowledge transfer enhances the improvement of the operational capabilities of the individual crew member without burdening the
other team members with the task, additional to their normal workload, to break in newly stationed crew members.

The use of a computer based system with self testing and final testing capabilities allows the individual crew member to absorb the information at his own speed and test for himself in how far he has mastered the information material and also provides the master with a means to value objectively the operational capabilities of each crew member even beyond the eventually existing language barriers.

The availability of a computer based knowledge transfer system will give the individual crew member an opportunity to widen the scope of his knowledge or to prepare himself for higher qualification or certification.

3.5 SIMULATION AS SHORE BASED TRAINING

Despite efficient communications providing effective distance education, the seafarer will still need to attend shore-based courses for both induction and post-entry upgrading training. Simulation will be used on many of these course to provide a sufficiently realistic workplace environment. The value of simulators as a training and assessment tool has been increasingly appreciated worldwide.

The advent of computer technology has boosted the development of marine simulators. Today, there are numerous categories and levels of simulators available for training of seafarers. For the training of marine engineers, they can range from a simple computer-based simulator to a full-mission simulator.
which combines real control room instrument consoles with mimic panels
interface and sound effects to increase realism.

Maritime training in simulated situations, though still in its infancy, is
developing rapidly and will play a much greater role in future. More
recognition of this role is necessary and regulatory requirements need to be
amended to recognise competencies developed and assessed under simulated
conditions.

Simulation provides the means for overcoming many of the difficulties
inherent in this type of training. Simulators are particularly useful for testing
reaction to emergency situations. Development of the "seacockpit" concept
for the bridge on high speed vessels is likely to lead to much greater use of the
simulation training methodology already used in the training of airline pilots.
However, human factors - stress, fatigue, panic, poor teamwork, poor
communication, misunderstanding, the need for good command of "Maritime
English", have not been given sufficient attention. The use of simulation in
maritime training does not however necessarily mean expensive electronic
imagery. Very effective basic level survival training can be carried out in fire­
fighting centres and in enclosed pools with facilities for launching survival
equipment and jumping from heights in darkness. Simple PC programmes are
already widely used for teaching of lights recognition, rules of the road and
basic understanding and use of electronic navigational aids. There will be
much greater use of PC programmes in the near future.
3.5.1 ADVANTAGES OF SIMULATION

The advantages of using simulators as a training aid include:

a) Improved training due to the "hands on" nature of simulator learning
b) The ability to cover a wide range of topics in a relatively short period of time
c) The ability to expose participants to a wide range of situations and experiences in a short period of time.
d) Participants obtain virtually instantaneous feedback response to their decisions and actions resulting in improved reinforcement of their learning
e) Accelerate confidence building and greater awareness of their responsibilities
f) Improved man-management, teamwork and onboard training techniques
g) Development of desirable attitudes and also diagnostic and fault finding skills
h) Safety hazards are eliminated
i) More readily available than the real thing
j) Fast time presentation and freeze mode of dynamic processes
k) Savings in time and equipment make them cost effective
l) Simulator time replaces real time for acquiring certificates
m) Overall reduction of training costs
3.5.2 DISADVANTAGES OF SIMULATION

There are many advantages to the use of simulators in training situations. It would be unfair to claim that there are only advantages and not some considerations to be made. The disadvantages of using simulators are:

a) Relatively costly, compared to the traditional means
b) Experience instructors required
c) Complicated equipment which can fail
d) Scheduling of sessions different from classical teaching

3.6 FUTURE TRENDS IN MET

The direction of the technological development in shipping is the most important factor influencing present and upcoming education and training requirements. The two main trends to come in the years are the following:

- a "revolution" in communication and information technology.

- increased use of computers and artificial intelligence and decision support tools on board.

A tendency towards more sophisticated ships will continue and will influence the way in which countries manage and implement their MET.
Short (1993) summarises his vision of the evolution of maritime education and training into the 21st century in the paragraphs below.

Mankind's increasing dependence on the sea will require greater knowledge, understanding, effective regulation and wise exploitation of matters maritime and resources of the sea. Maritime education, training, research and development will grow in importance.

The great global industry of maritime transport will become safer and more efficient through a substantially improved system of training and certification in which the following development will pay a major part:

1. distance learning by seafarers on board ships at sea using satellites and interactive telecommunications technology and distance learning methodologies;

2. more effective shore-based learning for all students of matters maritime making greater use of the realism of computerised simulation;

3. a global network of maritime educational institutions whereby a large number of primary training centres are linked with high budget key centres for advanced work and research and development; and

4. global standards, including competency based standards of training, together with a globally recognised system of modular course components, accreditation and articulation and of certification.
3.7 THE STCW 1978 CONVENTION

The International conference on the Safety of Life at Sea (SOLAS), among the many resolutions adopted in 1960, called upon Governments to take all practicable steps to ensure that the Education and Training of seafarers in the use of aids to navigation, ship's equipment and devices was sufficiently comprehensive. IMO and ILO co-operated with each other and with interested Governments in achieving these ends.

A joint IMO/ILO committee on Training was established. The committee prepared an international maritime training guide entitled the "Document for Guidance-1964". This document made recommendations on the Education and Training of masters, officers and seamen in the use of aids to navigation, life-saving appliances and devices for use in the prevention, detection and extinction of fires. The document was adopted by both IMO and ILO but its implementation was not mandatory to members of the Organisation. The document was subsequently amended, expanded and supplemented by the Joint Committee in 1975, 1977 and 1985.

It is to the credit of the World Maritime Community and IMO that in the year 1978 they adopted through an IMO conference the "International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978" (STCW 1978 Convention). Thus emerged the first ever set of international regulations in this regard.
3.7.1 ENGINE DEPARTMENT TRAINING

The convention provides for three grades of certificates for engineer officers namely, chief engineer officer, second engineer officer and engineer officer in charge of a watch in a traditionally manned engine room or designated duty engineer in a periodically unmanned engine room. The certificate structure is further subdivided in accordance with the power output of the main propulsion machinery with steps provided at 3,000 kw. No certificate is prescribed for engineer officers in ships powered by main propulsion machinery of less than 750 kw.

There are different minimum knowledge requirements for chief engineer officers and second engineer officers of ships powered by main propulsion machinery of 3,000 kw propulsion power or more and for such officers of ships powered by main propulsion machinery of 750 - 3,000 kw propulsion power. The level of knowledge required for a grade of certificate may be varied according to whether the certificate is being issued at chief engineer officer or second engineer officer level.

An engineer who is qualified to serve as a second engineer officer of ships powered by main propulsion machinery of 3,000 kw propulsion power or more, may, provided he has served an approved sea-going service of not less than 12 months as an engineer officer in a position of responsibility served as a chief engineer officer of ships powered by main propulsion machinery of less than 3,000 kw propulsion power.
The convention also established mandatory requirements for certification of engineer officers in charge of a watch in a traditionally manned engine room or designated duty engineer officers in charge of a periodically unmanned engine room. Administrations are allowed for this certificate to vary some of the requirements with respect to approved education and training and period of sea-going service contained in the convention.

As with deck department, there are mandatory minimum requirements for ratings forming part of an engine room watch. Such ratings have to meet the convention requirements with respect to minimum age, medical fitness, training or experience in watchkeeping duties and procedures and knowledge of safe working practices as related to engine room operations. They are also required to have training or experience regarding fire-fighting and basic first aid.

### 3.7.2 THE STCW 1978 CONVENTION - SUCCESS AND LIMITATION

#### 3.7.2.1 SUCCESS

The essential objectives of this convention were:

- to establish global minimum standards of competence for various levels of officers (and key ratings) concerned,
- to achieve global harmonization of the "standards" of training and examination of aforesaid personnel, and
to facilitate global recognition and acceptance of the certificates granted under the convention.

Considering that this international Convention was the first of its kind in Maritime history, the very adoption of it is a success story. According to IMO Document (1993), so far, 101 countries having 92.93% world Tonnage of ships have become parties to this convention establishes the degree of success hitherto. The real aim of the international maritime community which adopted the STCW Convention was to ensure at least the appropriate minimum degree/level of competence of seafarers in every category covered by the convention, on a global basis.

Accordingly the Convention prescribes not only the appropriate professional knowledge required for each category but also other minimum requirements such as sea-going service, as well as the limits to which periods of special "training" may be substituted for the purpose. Thus the convention has succeeded in prescribing harmonized "standards" of professional knowledge as well as in indicating the extent to which the different "systems" leading to certification of various categories of seafarers would have to be adapted or adjusted or improved or developed.

3.7.2.2 LIMITATION

The Convention prescribes minimum "standards" but does not address the "systems" followed or to be followed. The aim was evidently to achieve the "standard" through successful systems already in existence or to be created similarly.
Any effort to change traditional or inherited systems was (and still is) no easy matter.

3.8 REVISION AND NEW CODE PLANNED IN STCW CONVENTION

The introduction of a new code, containing technical details will be involved in the revision of the STCW, 1978 convention due to be adopted next year. The revised convention will be restricted to broad principles and legal arrangements.

This was agreed by the Sub-Committee at its 25th session held from 17 to 21 January 1994.

The code would be much easier to amend than the Convention and the proposed arrangement would therefore enable technical standards to be updated more easily. The salients features of the code are detailed below:

- establishing and operating a maritime training institute
- establishing provisions for the certification of seafarers and administering a certificate system
- assessment of seagoing service for all types of certificate
- assessment of knowledge and skills by means other than simulators
- the withdrawal, suspension and cancellation of certificates
- the endorsement and revalidation of certificates
- human element implications.
In principle, it was agreed by the Sub-Committee that the revised convention should include new regulation requiring seafarer to be provided with ship-specific instructions to ensure that they are familiar with equipment, procedures and other arrangements before being assigned to any safety and pollution-prevention duties.

The Sub-Committee agreed that simulators are important training aids and that the group of consultants appointed to expedite the revision should develop a section showing in what areas the use of simulators should be made mandatory. It was agreed that this should include training and assessment for radar and Automatic Radar Plotting Aids (ARPA). In some other areas, the use of simulator training could be recommended.

It is expected that the revised STCW 1978 Convention will be adopted at a conference to be held in July 1995. The revision is being carried out under an accelerated procedure in which much of the preparatory work is being carried out by a specially appointed group of consultants in maritime training and an intersessional working group. The review is also being assisted by the IMO/ILO Joint Committee on Training.

It is expected that the draft texts prepared by the intersessional working group will cover such matters as deck department and radio communications; engineering department, including electrical maintenance; basic safety survival; emergency training and fire-fighting; tankers and special types of ships; quality assurance, and audit; and administrative guidance.
The Sub-Committee will also review a new draft convention on the training and certification of fisherman, taking into account the proposed amendments to the STCW 1978 Convention.

Moreover, certificates obtained under alternative arrangement should be interchangeable with those obtained under the present Convention and the existing flexibility of a seafarer to transfer to different types of ship's, trades and flags should be maintained. The career development at sea and ashore, should not be impaired and the standards of competence for traditional and alternative certificates structures must be uniform.
4.1 MILESTONES

The use of simulation technology for training has been a feature of several industries for many years. The operation systems of the aircraft and nuclear power stations are outstanding examples, areas where some electronics manufacturers can point to over thirty years ranging from closed circuit television to computer generated imagery. It was a well-established science even before the application was utilised in the marine field.

In 1966, the first efforts in engine room automation was pioneered. A joint venture between Wilh Wilhelmsen, DMV, SFI, and Norcontrol was entered. The first marine computer system onboard a Norwegian ship was installed.

1970 Databridge. The first commercial anticollision, radar and integrated navigation system was introduced in the world.

1972 Datachief/Diesel. The world's first commercial computerised engine room automation system was produced for engine room plants.
1977 Navsim. The first computerized navigation and radar simulator was produced.

1981 Databridge-7. The third generation anti-collision system ARPA came into being.

In 1985, the NMS 90 was introduced. The third generation navigation and radar simulator.

1985 Cargosim, the first “full mission” cargo handling simulator was developed. In the same year further developments in marine systems process simulator were carried out.

4.2 DEFINITION OF A SIMULATOR

A simulator can be described as a device that duplicates limited aspects of the real world. The simulation process recognises all the classic benefits such as avoidance of costs and dangers associated with operation of actual systems, avoidance of injury and damage, rapid and repeatable exercises.

The complexity of simulators vary in accordance to the task they were designed for. A simulator is designed for training to give a dynamic representation of the system, under varying degrees of fidelity, to the trainee to enhance and carry out training in an effective manner.
4.3 TYPES OF SIMULATORS

Simulation equipment has been accepted by the education world to be an effective and powerful training tool. This is certainly the case for the maritime training world as the implementation of simulator systems in maritime training institutions is rapidly taking place.

Norcontrol Systems a.s., a Norwegian company, is the largest manufacturer and supplier of simulation equipment. The company has over ninety percent (90%) of the market worldwide.

In general, it can be said that any dynamic process or complex operational equipment is suitable to stand model for a simulator system. Skills training, concept training and understanding of interactivity of systems can be achieved by proper use of qualitative simulator systems.

Some of the types of simulators in use in the marine field are listed below.

Navigation equipment simulator
- either as stand alone or coupled to radar/navigation
- various modern electronic navigation instruments
- training of operating procedures and accuracy theory

Communication simulator
- radio communication systems linked to bridge or stand alone
- in full configuration fulfills GMDSS training requirements
Radar navigation simulator
- on basis of radar simulator
- navigating functions also simulated
- one or more bridges and possibly some slaves

Shiphandling simulator
- all components of above mentioned plus visuals
- various types of internal and external effects to be introduced
- full navigational instrument

Full mission shiphandling simulator
- as above but with full visuals
- sophisticated mathematical models
- mounted on platform for special effects
- interconnecting with other types of simulators

Fisheries simulator
- handling of fishing gear and ships equipment at the same time
- effectiveness of fishing operations can be reviewed

Inland waterway ship simulator
- specific elements of river navigation included
- with or without visuals

Dynamic positional simulator
- complicated dynamic positioning operations are trained
due to large number variables, rather intense operating procedures
specific types of DP equipment in use can be practiced

Liquid cargo handling simulator
- originally oil tanker simulation
- dynamic process of filling and emptying tanks to be simulated
- cargo distribution and stability/stress characteristics to be trained
- especially complicated operational vessels as gas, chemical, oil products are suitable and interesting

Ballast control simulator
- specially developed for ballast critical craft as oil rigs, off-shore construction ships, semi-submersible vessels etc

Dredging ship simulator
- dredging master station simulated with all instruments
- dredging operations and results are simulated and shown

Propulsion plant simulator
- replica of engine control room
- alarm and control panels as in engine room
- actual engine usually replaced by mimic consoles
- added noise to create life like operational influences
- can be coupled to bridge simulator
Steam generation plant simulator
- stand alone or part of engine room
- specific functions of steam equipment

Electrical power plant simulator
- stand alone or part of engine room
- specific functions of electrical supply and use

Refrigeration plant simulator
- stand alone or part of engine room
- specific equipment and physics to be simulated and practiced

Oilspill management trainer
- logistic involved in oilspill recovery operations
- with actual environment database also to be used for real spills

Vessel traffic management trainer
- as stand alone or coupled to bridge simulator
- logistics and communication in vessel traffic to be practiced

Offshore process control simulator
- complicated layout of offshore processing unit can be trained
- sometime more operators simultaneously working so procedures and communication skills to be practiced as well
Drilling technology simulator

- various techniques required in drilling operations
- bottom characteristics are simulated

4.4 ENGINE ROOM SIMULATION IN A NUMBER OF DEVELOPED COUNTRIES

4.4.1 AN OVERVIEW

Within the past few years, a number of engine room plant simulators have become available, and they have quickly become accepted as invaluable tools for the training of engine room personnel. Earlier simulators were either one, representing a particular installation or designed to be batch produced around one particular design. Several developed countries appeared to be following the establishment of a national training system involving traditional classroom teaching methods, but also adapting to modern technology in the way of Computer Based Training (CBT) and the increased use of simulators. Some countries are even going to the extent of using simulators for examination as well as training remission of seetime.

The followings paragraphs give examples of the Engine Room Simulator, types, objectives and methodology available in some developed countries having acquired experience in the field of simulation. A list of countries, having different types of engine room simulators, is included at Appendix II.
4.4.2 ENGINE ROOM SIMULATION IN UNITED KINGDOM

After a relatively slow start, the United Kingdom is now equipped with a comprehensive well-integrated range of maritime simulation equipment. Development of these simulators has been orchestrated by the Department of Industry over the past decade and the developments are now nearing completion. The first bridge simulator was inaugurated at Warsash in 1977, to be used almost exclusively for bridge teamwork training.

In 1984, the College of Maritime Studies (Warsash), the college being an integral part of the Southampton Institute of Higher Education, acquired a purpose-built Portakabin complex. In 1979, the Department of Industry and Haven Automation Ltd entered a collaborative agreement for the development and construction of a Slow Speed Diesel Machinery Space Simulator. The siting of the simulator was awarded to the above college.

1) The Slow Speed Diesel ERS

The simulator is modelled on a slow speed, direct coupled, reversible six cylinder, Sulzer RND90-M two stroke, cross-head, diesel engine of 20,000 BHP driving a fixed pitch propeller.

The construction of the buildings gives itself admirably to the feeling of being "onboard ship". Environmental realism is a major feature. Besides, the "Chief Engineer's Office" is fitted out with typical vessel documentation, library and instruction manual systems. In addition, to further enhance the "environmental realism", realistic machinery space, main engine and propeller sound effects
have been incorporated and respond according to the machinery space operating conditions.

The simulator is capable of the following operations:

* starting up from "dead ship"
* plant and main engine warming through procedures
* manoeuvring in:
  (i) engine room control mode
  (ii) bridge control mode
* operating the main engine at all loads up to 110% MCR
* fuel oil and cylinder lubricating oil consumption calculations
* running up and paralleling two diesel alternators and one steam turbo-generator
* load sharing between alternators including power factor adjustment
* up to 150 faults of varying nature and severity can be input by the instructor. Additionally, the simulator will correctly respond to any errors made by course participants
* operation of the main engine under "emergency run" conditions
* cooling down and returning to dead ship or "lay up" conditions
* operation of the machinery spaces on emergency diesel power and "split" electrical distribution switchboards
* operation of the machinery spaces when connected to "shore" power
* fire detection/alarm system and simulated fixed gas smothering system
2) Types of Courses

Courses are offered for various types and levels of training ranging from entry level appreciation courses to advanced level courses for experienced marine engineer watchkeeping officers and engine room teams. Courses are suitable for undergraduate/graduates reading for maritime-related first degrees/postgraduates qualifications. Available courses are:

1. Introduction of Machinery Space Operations and Practices (2 days)

This is a basic "entry level" introductory course to diesel propulsion plant systems and their operation. The participants in this course are assumed to possess theoretical knowledge of marine power plant systems but have little or no sea-going experience.

This course is also found to be suitable for maritime cadets going for their first sea-going appointment.

2. Watchkeeping and Operational Practices in the Machinery Spaces of Modern Motor Vessels (3 days)

This course is aimed at marine engineer officers and final year cadets needing to fulfil the STCW (1978) requirement for watchkeepers on vessels fitted with diesel propulsion plant. The participants are assumed to:

a) possess theoretical knowledge of marine power plant systems,
b) have satisfied the seagoing experience requirements for the Class 4 (Motor) Certificate of Competency,
c) intend to undertake the Examination for this certificate or its equivalent.

3. Plant Operations of Marine Engineer Officers (4½ days)

This course is designed for marine engineers having at least six months seagoing experience as a watchkeeper on vessels fitted with diesel propulsion plant.

4. Machinery Space and Propulsion Plant Operations - An Overview for Senior Navigating Officers (3 days)

This course is designed for pilots, ship's masters and senior navigating officers. The course aims to impart a greater awareness of the implications of specific systems failure and human error on the navigability of the vessels and the constraints place on marine engineers when dealing with such problems.

5. Power Cards Analysis, Emission Control, Fuel Management and Energy Conservation (3 days)

This course uses multi-media software packages, enabling participants to examine the various factors affecting combustion efficiency, engines exhaust emissions, engine performance, total plant performance, fuel efficiency and onboard fuel quality. Participants should thus be able to produce a more

55
effective and efficient input to enhance the safe and economic operation of the ship's plant.

4.4.3 ENGINE ROOM SIMULATORS IN SWEDEN

Engine Room Simulator training was initiated at the Chalmers University of Technology, Gothenburg, Sweden in 1985 and at the Sjöbefälskola in Kalmar.

They are based on a main engine of MAN B&W 6L90GFCA type and two colour graphics plants with programmes for the above-mentioned engine, together with programmes for MAN B&W 5L90MC type engine.

The simulators are used for different courses, namely, in the education of marine engineers, refresher courses for certification, further training courses and in the education of navigating officers.

In the three-year training of marine engineers, one Engine Room Simulator course and Machinery Plant Operation course are covered every year. The ERS programme is divided in the following way. In the first and second year of study, 40 hours are devoted to simulator training and 60 hours in the third year.

All the three simulator plants are used simultaneously. A group of three students work on each simulator. There are seven four-hour long exercises in the first two years and eleven exercises in the third year. The main purpose of the exercises is to aroused the responsibility for the safe operation of the whole engine.
In Japan, the constructions of highly modernized and rationalized ships have increased so as to cut down their running cost. Specialised crews with the required minimum technique for the ship's operation are needed to ensure the effective and efficient operation of the ship. In view of the foregoing, it is a widely accepted fact that the training using the simulators for the above kinds of technique is very effective, efficient and safe.

In 1985, the staff of the Marine Technical College, Hyogo, Japan, has developed an engine room simulator, based on the propulsion systems of a modernized ship. Since 1985, the simulator has served to train marine engineers as well as the deck officers.

1) Type of Simulator

The engine room training simulator is dynamically modeled on a slow speed diesel main engine propulsion plant of a 30,000 DWT (deadweight ton) container ship. The model is designated by the Ministry of Transport in Japan as a modernized ship whereby full automation system is equipped for the unmanned machinery space operation. Furthermore, the model is based on two types of the main diesel engines, SULZER 8RLB90 and MAN B&W 7K90MC. The simulator was designed to simulate various types of machinery and equipment as used in the engine room of a highly modernized and rationalised ship in Japan. The simulator can provide the following kind of training:
1. Understanding of operation of the main diesel engine and other machinery as a whole,
2. Training for the operation and control of the main diesel and other machinery,
3. Training for monitoring of the main diesel engine and other machinery in the engine room, which is necessary as the watchkeeper's duty.

2) Objectives of the Simulator Training

1. Comprehensive Understanding of the Propulsion System
To make the trainees grasp the role of each part of machinery composing the propulsion system from a viewpoint of energy conversion theorem, and the system engineering method which can easily represent the relationship between energy input and out put as a form of energy flow not only to the main system as a core of the diesel main engine such as the oil fuel system, the scavenging air system, etc; but also to the necessary sub-system, such as boilers, generators, etc.

2. The Operation of the Propulsion System
Not only to make the trainees understand the conditions (including interlocking gears and safety devices) needed for operating the propulsion system, but also to train them with each machinery, such as the main diesel engine, the auxilliary boiler, and generators, and besides in the operation of these machines connected. In addition to the operational training, the systems allows to make the trainees practise the operation at an emergency situation of the whole system and also of each machine, such as cylinder cut-off operation
of the main diesel engine. Moreover, to enable the trainee to practice a wide range of the propulsion systems' operational procedures from the dead ship mode to running mode and also its reverse procedure.

3. The methods of Monitoring and Diagnoses in the Normal and Abnormal conditions

To make the trainees experienced in monitoring method using the CRT (Cathode Ray Tube) display, the data logger and the instruments in the engine control room to confirm the normal conditions, to detect the abnormal conditions, to diagnose the failures, and to prevent damage of the propulsion system.

4.4.5 SIMULATORS FOR TRAINING OF MARINE ENGINEERS OF THE UKRAINE

The department of Diesel Plant Automation at the Odessa State Maritime Academy (OSMA), Ukraine, has been using different types of simulators for training of marine engineers during the last 20 years. In the period from 1985 to 1992, more than 1000 marine engineers have completed Machinery Space Simulator courses, as conducted at the OSMA Automation Department. The first simulators at the Academy were for main engine remote control and monitoring systems which were built by ASEA (JUNGNER INS) in 1971 and 1972. These were followed by a main engine remote control simulator built in 1982.
Problems of training to improve practical skills when working and interacting with simple information system were solved in the seventies with the use of the main engine control and monitoring simulators.

With the advent of simulators such as “Dieselsim” in the eighties, built by Norcontrol, provided the possibilities to improve the watchkeeping engineer skills. Subsequently, a “Dieselsim” engine simulator started to be used in the Academy in 1984.

In 1989, OSMA signed a contract with Haven Automation Limited for the supply of a new generation of power plant simulator, to meet the training requirements of the marine engineers for the new ship types. In 1991, the Haven simulator, type LSS-2, was installed at the Diesel Plant Automation Department, this simulator being the first example of its kind.

1) The LSS-2 Simulator

The LSS-2 simulates the automated power plant of a refrigerated vessel of 10,000 tons deadweight and consists of five working areas.

- the engine room with a 4 m² plant mimic panel and a PC computer terminal for parameter monitoring,
- the main switchboard with diesel, shaft and turbo-alternators, together with a 1 m² mimic panel,
- the main engine control room with two PC computers terminals for remote control and monitoring,
• the instructor rooms, which contains the bridge/main engine remote control desk with two monitors, the Intel master computer for the software and the sound system,
• a passive training room with two PC computers terminals for parameters monitoring, printers and plotters.

The main engine model of the simulator is based on a B&W 6L60MC slow speed diesel engine.

The electrical power generation systems comprise of two diesel alternators, a turbo-alternator, a main engine shaft-alternator and an emergency diesel alternator. A shore supply is also provided. Auxiliary machinery includes an oil fired and exhaust gas boiler, air compressors, oil separators, steering motors, high and low temperature centralised cooling water system, camshaft and cylinder oil system, bunker systems, stern tube oil system and refrigerating plant with chambers.

2) Training Skills

The Odessa State Maritime Academy has provided marine plant simulator training for the marine engineers over many years and with LSS-2 simulator they are able to provide a training programme which includes the following skills:

• use of modern data display systems and personal computers for power plant control and monitoring,
• marine diesel governor setting and adjustment,
- electrical plant operation, with fault diagnosis,
- plant and main engine preparation and warming through procedures,
- manoeuvering in different engine control modes,
- plant operation and diagnosis of faults of varying nature,
- operation of the propulsion plant in complex conditions.

4.4.6 USE OF ERS AT THE MARITIME POLYTECHNIC OF CADIZ - SPAIN

In 1988, a Norcontrol built, engine room simulator was installed at the Maritime Polytechnic in Cadiz. Since the installation of simulator, research has been conducted to find the most suitable training methodology so that the greatest results could be achieved from the simulation equipment. The simulator is based on the engine room of a fishing boat with a 2,000 kilowatts power propelling machinery, controllable pitch propeller and two diesel generators.

The main aim of the simulator training, is to achieve a higher degree of safety, experience in the handling and effectiveness in the control operations of installations of machinery of ships.

Fundamentally, students acquire the following:

a) Familiarization with the components, instruments and control used in the engine room.

b) A greater knowledge of the instructions, programming and stages in the procedures of starting the engines.
c) A correct method of keeping watch in the engine room.
d) To achieve experience in correcting problems and possible mistakes.
e) Improvement in taking decisions as they are essential for the correct running, efficiency and safety in plant operations.
f) To get the optimum regulation in the different control systems in the engine room.

4.4.7 SIMULATORS AS A SKILL COMPETENCY TESTING TOOL IN CANADA

In 1977, the Canadian Coast Guard Ship Safety Branch, in collaboration with Haven Instrument Company of United Kingdom, developed one of the first exclusive marine engineering simulator. Subsequently, in 1979, more units, manufactured in Canada, were installed.

In 1992, new specification was prepared for the purchase of new simulators. Consequently, a functional description was finalized which specified the operation of the simulator systems and an engineer skills assessment system.

The provision of modern simulator facilities within the Examination System of the Coast Guard Ship Safety permits examiners to thoroughly evaluate the candidate’s knowledge and skills to efficiently operate machinery and diagnose operational problems in the unique environment of ship’s machinery systems without imposing the danger of life threatening situations.
1) Training Offered

The simulator examination program in place for the engineer officer is in Level I and II, while a third level, Energy Management, was prepared at the request of the marine industry for general training of managers with the corporate structure.

The level titles and certificates related to each level are as follows:

**Level I** - Watchkeepers, Control Room Operators

- Fourth class certificate
- Watchkeeper Motor Driven Fishing Vessel (MDFV)
- Chief Engineer MDFV

**Level II** - Plant Managers:

- Third class certificate
- Second class certificate
- First class certificate

**Level III** - Energy Management:

- Engineer Officers
- Navigating Officers
- Superintendents
- Traffic managers

The first two levels are sub-divided into three units consisting of:

a) Simulator familiarization,
b) Operational, and

4.4.8 USE OF ENGINE ROOM SIMULATORS AT THE NANTES
MERCHANT MARINE ACADEMY - FRANCE

The first diesel simulator was installed in 1988 at the Nantes Merchant Marine
Academy. Eventually the colourgraphic version was added in June 1992.

The diesel simulator is based on a 187,000 DWT tanker powered by a 17,400
KW slow speed B&W MAN diesel engine. The whole system consists of an
instructor room, and engine room and a control room.

1) Trainees Background and Levels

Most of the students are from the Academy and Saint Malo, Le Havre. Around 12% are from other institute, 2% of the trainees are from shipping companies and shipyards and 1% from the Maritime Administration School. The trainees spend one week, that is, 30 hours with the simulator training. For trainees coming from the shipping companies, shipyards or industries, the training aims are tailored according to customers' requirements.

The training exercises grow more complex as the level of trainees go up. The training sessions are divided into two levels; namely, for beginners and advanced trainees.

For beginners, the full plant is used but it is neither desirable nor necessary to insert faults. For advanced trainees, normally with sea experience, do the
watchkeeping duties and diagnose faults which have been introduced. The capabilities of the diesel simulator are:

a) Running with inserted failures,
b) Running with possibility of 400 faults. The fault appears at an exact time or randomly. The trainees make diagnosis and repairs,
c) Calculation of thermal balance and efficiency for engines, boiler, tubo-generator, coolers etc.
d) Study of control loop and tuning of a PID controller,
e) Miscellaneous.
CHAPTER V

A PROPOSED TRAINING CURRICULUM FOR DIESEL ERS

5.1 TRAINING REQUIREMENTS

5.1.1 PHILOSOPHY OF SIMULATION

Over the years simulator training has proved to be an effective training devices when training marine engineer officers, especially where an error of judgement can endanger life, environment and property. Years of experience can be compressed to a few weeks on a dynamic real-time computerized simulator and can also give knowledge of dynamic and interactive process typical for a real engine room.

Engineer officers will gain the appropriate and necessary experience and confidence in their job situation if simulator training is implemented in a proper way, consequently leading to a reduction in accidents and improvement in efficiency.
Before the simulator was introduced, learning, from real life, in a real engine room, was the best and only one way to acquire practical experience. But today this kind of onboard training can be carried out on a simulator. Practicing decision-making in a simulator environment where decisions and their effects are monitored, opens an unique possibility to evaluate the effect of the decision.

Simulator training gives opportunities to experiment on specific problems and various questions can be answered without wrecking components. A simulator will give an easy introduction to background theories through the realistic operation of the simulator.

It is of paramount importance that the trainees experience realistic conditions on the simulator. The task that they are asked to carry out, should be regarded as relevant and important in their job-situation. The trainees should be challenged at all levels of experience in order to achieve further experience and confidence.

5.1.2 BROAD TRAINING REQUIREMENTS

The main purpose of simulator training is to be able to train junior engineers in basic engine room operations, senior engineers in emergency operations and trouble shooting, and to train senior and chief engineers in optimal operation, fuel consumption and energy conservation. This will be achieved by controlled training leading to better understanding of the total plant operation, as a function of a realistic simulation of a real engine room.
To fulfil the above requirements the simulator shall be able for, but not limited to:

a) Basic and advanced training and education of students leading to professional qualifications and higher qualified engineers.

b) Refresher and recurrent training for qualified engineers and chief engineers.

c) To train engineers in the operation of a ship's machinery together with the most vital auxiliary equipment.

d) To enable detailed studies in the different processes of ship's machinery.

e) To train engineers in the location of faults and deterioration and to clearly demonstrate the impact of various types of fault and deterioration on the plants total efficiency.

f) study of overall fuel consumption concept.

5.1.3 GENERAL SPECIFIC OBJECTIVES

To ensure appropriate training, the simulator shall at least be capable of creating such situations, depending on the background knowledge and experience of the trainee. The appropriate training are placed below:

**Basic Operational Training**

- Starting ship machinery from "dead ship" state
- Harbour operation
- Preparation for getting underway
• Maneuvering to open sea
• Steady steaming
• Maneuvering in harbour
• Finishing with the engine
• Operation of auxiliary boiler and cargo turbines
• Know how to respond effectively to abnormal and emergency situation.

Advanced Operational Training

• How will an engineer react when faced with series problem
• How will crew members operate together when an abnormal situation develops
• How can errors within the system be traced and corrected
• How can the engine room system be restored to normal operation.

Economy and Optimizing Studies

• How to judge the performance of various components
• How to differentiate between external and internal causes of a deterioration in performance
• If a certain performance deterioration occurs on a given component, how much will this affect the overall fuel consumption
• How can running and tuning of various components of subsystems influence overall fuel consumption.
5.2 DEVELOPMENT OF SIMULATOR EXERCISES

The figure 5.1 may be used as a guideline for designing exercises on simulator machinery. The main steps illustrated are explained in details below.

Step 1 - Introduction

The simulator equipment characteristics dictate the amount of control that the instructor has over the exercise. Although it is appropriate to design flexibility into a simulator in order to assist the instructor in maximising the training benefit, it is necessary for the instructor to position the type of exercise with the area where the simulator gives the best training results.

Step 2 - Special learning objectives

This specifies what the students shall be able to do after the training. Specification of main and secondary training objectives is possible. Is the objective taken from some documentation? What connection is there between this exercise and the whole training programme?

Step 3 - Duration of exercise

Specify time for briefing, simulator training time and time for debriefing, discussion and possible evaluation.
Step 4 - Number of students per instructor

The student : instructor ratios of 4:1 or 6:1 should be feasible. However in the beginning stage 2:1 might be required.

Step 5 - Special instruction for the instructor

The instructor guidance is a technique where relevant information concerning the appropriate procedures is provided to the trainees during the training exercise on the simulator. This is different from briefing and will consist of positive guidance by explaining, demonstrating, commenting during the exercises as regards to the proper considerations and action to be taken. The level of instructor guidance should be determined prior to the exercise.

Step 6 - Special instructions to the students

The exercise given to the trainees should be as specific as possible. When performing the exercise the trainees can write down their plans and compare these with the action being carried out on the simulator.

Step 7 - Status

Specify the initial condition or status of the simulator at the time the exercise will commence. For example: main engine running under normal conditions
Step 8 - Debriefing

Debriefing after the exercise is of great importance in order to acquire knowledge about the effect of the exercise. The main elements in the debriefing are the recorded, started data, the written plans of the students and the instructor.

The following questions can be considered for the debriefing:

- was the situation realistic enough?
- was the situation correctly understood?
- were the aims and objectives correct?
- were the actions taken correctly?
- were the procedures carried out correctly?
- were the results of the actions as expected?
- what was the result of alternative action?
- were the aims and objectives reached?

Step 9 - Evaluation

Evaluation should be divided into various components:

- evaluation of the effectiveness of the exercise
- evaluation of the quality of the exercise
- evaluation of the trainees achievements
- evaluation of the exercise with the programme as a whole
The evaluation of the effectiveness of the exercise, the quality of the exercise will come from the debriefing and from the students scores. Evaluation of the students performance is important if any marks have to be given, but depending on the type of simulator, is also rather complex, possibly not always as objective as required.
Fig 5.1: Steps in Developing Simulator Training Course

Source: General Simulator Instructor Course - Norcontrol a.s.
5.3 DEVELOPMENT OF A DIESEL ERS TRAINING CURRICULUM

Simulator training has to be well-structured and planned to be effective. Planned simulator training is a systematic, organized form of training designed to meet the requirements of a defined objective. The actual level of knowledge and skills and prior technical education of the trainees should be kept in mind during the planning and any areas within the detailed plans which may cause difficulties because of differences between the actual trainee entry level and that assumed by the designed plans should be identified. The programmes should also incorporate any academic knowledge, skills or technical training which may not have been acquired.

5.3.1 SCOPE

The design of the curriculum of this programme is primarily based on IMO model courses. The first phase of this programme is aimed to train and upgrade the skills of marine engineer officers of fishing vessels. Taking into account the rapid growth of Mauritius maritime sector and the Government's progressive policies, the second stage of the training would be to train marine engineer officers of merchant fleets. It is believed that the implementation of simulator training at the MSTS would enhance maritime training and would put the Maritime Education and Training system in the main stream of our educational system.
The programme is essentially a practical one, consisting of a series of exercises structured around the operation of a ship's machinery installation and carried out in conjunction with an engine room simulator.

An instructor would control the exercises, in the first placed, allowing the trainees to become familiar with the instrumentation and controls used in the engine rooms of modern ships, as well as develop the ability to become skilled in the scanning of the instruments displays when assessing the normal operational conditions of engineering plant.

The complexity of the exercises increases as the course progresses, as the trainees work through and become familiar with the procedures used for starting up auxiliary and propulsion plants, setting the normal operation condition and keeping an engine room watch. The final exercises deal with the procedures and techniques needed for the location and trouble-shooting of faults and malfunctions that can occur in an operational plant.

The trainees will assume different roles in the engineering watchkeeping team, during the series of exercises, with at least one opportunity to take on the part of the engineer in charge of the watch.

5.4 TRAINING OBJECTIVE

On successful completion of this programme the trainees will make a safer and more effective contribution to the operation and control of the ship's machinery installation.
In particular, trainees will gain:

- familiarization with the use of instrumentation and controls extensively used in the engine rooms of modern ships.
- a greater awareness of the need for proper pre-planning and the use of checklists, and of the timescale involve in start-up procedures.
- a greater understanding of the way in which machinery units are interdependent.
- an acquisition of experience in identifying operational problems and trouble-shooting.
- an improvement in their ability to make decisions which promote the safety and efficiency of an operational plant.

5.5 TRAINEES INTAKE LIMITATIONS

The number of trainees who can utilize the simulator in any given activity will be regulated in the programme intake. Depending on the activities, some may only allow three, or at the most four trainees to be directly involved in a simulator exercise. Therefore sub-groups have to be formed, and activities would have to be phased so that all trainees can receive the same period of training on the simulator. The number of trainees intake for the course should therefore be limited to a maximum of twelve (12). The briefing and debriefing sessions, according to circumstances, could be carried out as main group or sub-group activities.
### SUBJECT AREA

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Familiarization</td>
<td>6</td>
</tr>
<tr>
<td>1.1 Plant arrangement</td>
<td></td>
</tr>
<tr>
<td>1.2 Instrumentation</td>
<td></td>
</tr>
<tr>
<td>1.3 Controls</td>
<td></td>
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<tr>
<td>1.4 Operational procedures</td>
<td></td>
</tr>
<tr>
<td>2. OPERATION</td>
<td>9</td>
</tr>
<tr>
<td>2.1 General procedures</td>
<td></td>
</tr>
<tr>
<td>2.2 Auxiliary units and Systems</td>
<td></td>
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<tr>
<td>2.3 Diesel-driven generator</td>
<td></td>
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<tr>
<td>2.4 Steam boiler</td>
<td></td>
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<tr>
<td>2.5 Steam-driven turbogenerator</td>
<td></td>
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<tr>
<td>2.6 Steam cargo pump</td>
<td></td>
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<tr>
<td>2.7 Main-propulsion diesel engine</td>
<td></td>
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<tr>
<td>3. WATCHKEEPING</td>
<td>8</td>
</tr>
<tr>
<td>3.1 Taking over and accepting an engineering watch</td>
<td></td>
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<tr>
<td>3.2 Watchkeeping routines and duties</td>
<td></td>
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<tr>
<td>3.3 Main engine operation</td>
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<tr>
<td>SUBJECT AREA</td>
<td>HOURS</td>
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<td>-------------------</td>
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</tr>
<tr>
<td>4 TROUBLE-SHOOTING</td>
<td>7</td>
</tr>
</tbody>
</table>

4.1 Main propulsion unit operating at full power
4.2 Trouble-shooting procedures

Total 30
### TABLE 5.2 ENGINE ROOM SIMULATOR PROGRAMME 
**TIMETABLE**

<table>
<thead>
<tr>
<th>PERIOD/DAY</th>
<th>DAY 1</th>
<th>DAY 2</th>
<th>DAY 3</th>
<th>DAY 4</th>
<th>DAYS 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Period (1.5 hours)</td>
<td>1. Familiarization (1)Briefing session 1.1 Plant arrangement</td>
<td>2. Operation (1)Briefing session 2.1 General procedures</td>
<td>2.7 Main Propulsion Diesel Engine</td>
<td>3.2 Watchkeeping routines and duties</td>
<td>4.1 Main Propulsion unit operating at full power</td>
</tr>
<tr>
<td>2nd Period (1.5 hours)</td>
<td>1.2 Instrumentation 1.3 Controls</td>
<td>2.2 Auxiliary units and systems</td>
<td>2.7 Main Propulsion diesel engine (contd) (2)Debriefing session</td>
<td>3.3 Main engine operation</td>
<td>4.2 Troubleshooting procedures</td>
</tr>
<tr>
<td>3rd Period (1.5 hours)</td>
<td>1.4 Operational procedures</td>
<td>2.3 Diesel-driven generator</td>
<td>3. Watchkeeping (3) Briefing session</td>
<td>3.3 Main engine operation (contd)</td>
<td>4.2 Troubleshooting procedures (contd)</td>
</tr>
<tr>
<td>4th Period (1.5 hours)</td>
<td>1.4 Operational procedures (contd) (1)Debriefing session</td>
<td>2.5 Steam-driven turbo-generator 2.6 Steam cargo pump</td>
<td>3.1 Taking-over and accepting an engineering watch</td>
<td>(3) Debriefing session</td>
<td>4.2 Troubleshooting procedures (contd)</td>
</tr>
</tbody>
</table>

Source: IMO Model Course 2.07, Engine Room Simulator.
Note: The simulator programme may be extended depending on the trainee level and the duration of the course. If the trainees have no sea experience, more time should be spent on the engine room simulator to familiarize themselves with the equipment used in a real engine room.

5.7 INSTRUCTOR QUALIFICATIONS

The influence an instructor has on the training effectiveness should not be underestimated. Especially in sessions with older, experienced trainees it is found that the impact of correct type of instructor and his attitude towards the trainees is of vital importance.

Ideally, an instructor should have at least the same general knowledge as the trainees have or are expected upon finalization of a simulator instructor course. This means that for instance an engineering training course should be carried out by an instructor possessing the same or higher qualification as the trainees.

Although an instructor or trainer is not expected to have an answer to every question which is put to him, he does lose credibility if he is not able to answer any of the question at all. Naturally the up-to-date experience factor of the trainees will be greater than that of the instructor, particularly if the training is of a refresher course nature.

On the other hand an immediate avalanche of theoretical knowledge that is dropped on the new group of trainees does not exactly create the right atmosphere for effective learning to take place. Many factors will influence
the approach but the delicate balance should always be sought by the instructor.

5.7.1 SUBJECT RELATED KNOWLEDGE

Ideally the instructor should hold at least the same qualification as the trainees he is supposed to instruct. Not only will it add to his prestige, it will often prove essential to get the message across properly with all the small nuances involved as a training course reaches a higher level of sophistication.

In fact, this will always be possible. The higher or more specialized the training, the more difficult it becomes to have instructors holding the qualifications as the trainees.

In general, however, one can say that without any sea-going experience it will be hard to cope with all the routines items of the trade or the jargon, when having to train seafarers, in for instance, a new type of engine room layout.

5.7.2 EXPERIENCE

There is great importance for the simulator instructor to have a thorough background or experience in teaching or instructional techniques. It will be just as necessary to have the skills to organize a lesson, transfer knowledge and ideas, relate to people in simulator training as it is done in training systems using other tools. The required experience may be have been gained at various levels in various ways as detailed below:
• proper pedagogical teacher training at a regular teacher training institution.
• a simulator instructor course possibly upon installation of the system in the institution.
• previous instructor experience, ideally using simulators.

It goes without saying that previous instructor experience is of utmost value in the staffing of a simulator centre. However it will not always be present in the candidates available.

The instructor should have the capability to organize and conduct a briefing session before the exercise. The concept, have to be explained in a comprehensible language, monitor and supervise the trainees during the exercise in a constructive way. The right amount of instructor interaction is important to be established during a training session. Too much assistance during the training tends to demotivate the trainees. On the other hand, not enough guidance might cause a student to miss essential elements programmed in the training exercise.

The debriefing activities offer another area of possible mishappening. At the cadet level a lecture type of debriefing can be used. Experienced adult trainees require a totally different approach and here a debriefing discussion should be considered.

Some trainees will probably need a bit more debriefing and comments than others. The trainees background, culture, personality, age, group mates all
have influence on what is appropriate and how sensitivities should be dealt with.

5.7.3 MOTIVATION

The enthusiasm of the instructor for the training programme, exercises and equipment are one element in the success of a course. The instructor should genuinely recognize the importance of training and convey this to the students. An instructor who does not believe in the instruction can hardly be taken seriously by the trainees.

The situation becomes worse when the over-experienced trainees lead to demotivation of the instructor as there is no more real challenge in the task to be performed. This will immediately have a negative effect on the training efforts and the students success in the simulation course.

5.8 LAYOUT OF SIMULATOR SYSTEMS

Every simulator will have its specific requirements. Generally, real situation will try to be achieved as close as possible.

In general, simulator designs use three options placed below:

- operational version simulator
- workstation version simulator
- combination of both types
In the operational version the trainees encounter equipment and consoles as can be found on board real ships. This gives the possibility of hands-on training which in some situations is considered best.

In work station version a number of colourgraphic workstations with special functionnal keyboards are used to represent mimic diagrams of the systems incorporated in the simulator. This version is especially suitable for in depth studies of processes and subsystems.

As the simulator systems are built up modularly combinations of workstations with operational consoles can easily be realised. This way of configuration offers total flexibility in training objectives, sheduling and instructor involvement.

A number of examples of layouts of different systems has been included at the back of this chapter, but, depending on the specific requirement, every institution will have their own layouts.

5.9 MEDIUM SPEED ENGINE ROOM SIMULATOR

In general, the engine room simulator consists of equipment seperated in three different compartments, including the following:

The engine room control consisting of:

- Control Room Consoles
- Main Switchboards
- Alarm system / Printer
The engine room comprising of:

- Local operational engine room panels (alternatively mimic panels)
- Loudspeakers for the sound system

The instructors's room consisting of:

- Instructor's operational facilities
- Registration equipment, terminal and printer (event log)
- Sound amplifier
- Main simulator computer

The Diesel Plant Models form a complete diesel engine plant. The simulation models are based on real time programming, and therefore able to produce the dynamic behaviour of the engine room plant and all its vital parameters as well as the interactions between the sub-systems of a diesel plant.

The simulation models simulate the engine room components with their processes, as well as modern controller systems (sensors, controllers, actuators, valves etc.) connected to the processes.

The main engine is modelled as two medium speed, turbocharged diesel engine equivalent to Pielstick types, 520 rpm, 230 KW. The ship model is based on a multipurpose vessel, the main engine models respond dynamically to variations in operation and conditions of the ship.
models, and the ship models have a mutual response to the main engine models.
Fig 5.3a. Engine Room Simulator Layout

Source: Norcontrol a.s.
Fig 5.3b. Engine Room Simulator Layout

Source: Norcontrol a.s.
Fig 5.3c. Engine Room Simulator Layout

Source: Norcontrol a.s.
CHAPTER VI

ASSESSMENT AND VALIDATION OF MARINE SIMULATOR TRAINING

The final stage in the training process is to find out how effective the training has been. There are a few who would disagree with this and yet practice tends to suggest that in many institutions/organisations validation of training is either ignored or it is approached in an unconvincing or an unprofessional manner. In some institutions, it has been claimed that validation is too costly, it does not really proved anything or it is not really applicable because training cannot be valued in financial terms. Some trainers have reflected a defensive approach to validation because they felt that it invites criticism and apportions blame when training has not been as successful as it might have been. However if training is to enjoy the high profile which it is beginning to present, then thorough validation of its activities is vital so that, along with other departments, the training department can demonstrate its worth.

This chapter considers some aspects of assessing the effectiveness of training for marine simulators. It takes into account the importance of defining specific training objectives, taking into consideration the limitations imposed by the medium. Methods of validating training effectiveness on simulators are
Moreover transfer of training effects and its importance to performance validity are explored.

6.1 VALIDATION PROCESSES

In most diagrammatical representations of a training system, validation is shown as two discrete parts of the process which are described as internal validation and external validation. In practice they are intimately linked and most trainers see them as a single function because one is dependent upon, or has little value without, the other.

(i) INTERNAL VALIDATION

Internal validation is concerned with assessing whether a training activity has achieved its objective, in other words, "did the trainees learn what they were taught?".

(ii) EXTERNAL VALIDATION

External validation aims to find out if the former trainees have applied what they have learned in training to the job context and whether they are able to perform to the level expected of them after training.

(iii) VALIDATING BODIES

Assessment by staff of the institution may be in accordance with a training plan devised for simulator training, but it will carry more weight if it is
validated by the companies and agencies which they employ. It will carry even greater weight if validated by an independent external body. Independent bodies which may validate training include:

- International Organisations
- National Safety Authorities (responsible for issue of certificates)
- Employer's / Trade Union Associations
- Training / Quality Assurance Organisations
- Professional Bodies
- Classification Societies (as in Quality Management Schemes)

There may be other categories of public or private quality assurance bodies. In order to qualify for valid certification, certain procedures have to be followed and standard reached.

(iv) VALIDATING PROCEDURES

Validation procedures vary from institution to institution, but usually include approval and auditing of some or all of the following:

- the content of the training programme
- training methods
- the training facilities and environment
- entry qualification, maturity and experience of the trainees
- qualifications and experience of trainers
- the assessment programme
Validation is normally carried out by a panel of qualified professionals, and is normally subject to regular auditing and re-validation and updating of programmes at intervals, typically five or ten years.

6.2 EVALUATION OF TRAINING

The word evaluation may be defined in different ways. Evaluation can be defined as any attempt to obtain information or feedback on the effects of a training programme and to assess the value of training in the light of that information.

For any training programme to be fully evaluated, information has to be collected on a wide range of factors involved in the training activities.

Evaluation is needed in order to improve future training efforts and to eliminate those programmes which are ineffective. If the method is known for instance by breaking it down into logical steps, evaluation of a training programmes changes from a complicated, difficult process into a clear and achievable goal.

6.2.1 STEPS IN THE EVALUATION PROCEDURES

In general, for maritime related training, evaluation of the effectiveness of training moves from the training context into the work environment. The trainer is naturally going to be concerned with how well the training experience has enabled the trainees to perform certain duties, tasks and responsibilities to the required standards. In other words, to what extent and
have the knowledge and the attitudes acquired through training transferred to the job. In addition, the trainer is likely to want answers to the following complimentary kinds of questions:

- Have all the training needs of the trainees/job holders been satisfied?
- What factors have facilitated or prevented training transfer?
- Were the methods and procedures employed on the training programme entirely suitable?
- What additional learning, if any, took place on the training programme that was not covered by the formal training objectives?
- Was all the training context have been learned more effectively on the job?
- To what extent can job performance or changes in the job performance be attributed to the influence of the training programme or other influences?

Answers to these questions should help the trainer to confirm the adequacy or otherwise of training programmes by identifying the reasons for past and current successes, failures and errors of omission and commission. However, in order to undertake this evaluation in an effective manner, the trainer will have to address a number of further questions, issues and concerns.

**What specifically should the evaluation cover?**

This should be dedicated mainly by the objectives of the training programme and by the particular questions the trainer wishes to answer. The training
objectives will sometime indicate the criteria and standards against which the trainees' post-training job performance should be judged. The agreed job and performance objectives establishment through this process should be expressed in terms of the behaviours, actions and results expected of the trainees on their return from the training event.

When should the evaluation take place?

To a large extent this should depend on the nature of the or position in question and the time required for sufficient relevant information on the trainee's on-the-job performance to become available. In theory, this suggests that it might be appropriate to conduct a series of evaluations spread over the post-training period to measure the emerging performance of trainees as it relates to the different agreed objectives. However, in practice this is likely to be extremely unrealistic. The trainer will, no doubt, in many circumstances, need to strike some kind of balance and compromise. The necessary judgement, as to when to conduct the follow-up evaluation, should be made easier if the trainer is very familiar with the make-up of the job and the circumstances in which it is performed.

Who should be involved in the evaluation?

The two obvious candidates are the trainees and trainee's immediate line manager. In most cases the latter should have frequent enough direct or indirect contact with the trainee to make an informed and reliable judgement about their work performance and related matters. Whoever is involved must
have sufficient knowledge and skill, gained through training, experience and integrity to be able to make an evaluation in an unbiased and rational way.

6.2.2 METHODS AND TECHNIQUES OF EVALUATION

The trainer could employ, separately or in combination, a number of methods and techniques to cover the questions and issues of interest at this level; the main ones are outlined below:

(i) Questionnaire.

The questionnaire can be employed to help the trainer to answer most of the questions of interest highlighted at the beginning of this section. Usually, it is recommended that this document be kept brief and simple as short questionnaire are more likely to produce higher response rates. However a potential disadvantage of short questionnaire is the limited detail and sometime ambiguous information supplied. The trainer can combat this problem to a certain extent by careful design and thorough piloting of the questionnaire.

(ii) The follow-up interview.

A follow-up interview or series of interviews and structured interview proformas can be used to obtain details not captured through the questionnaire. This is particularly important if attention is being directed to:

- Re-appraising needs that had been identified earlier.
- Exploring the degree of transfer of training.
- Examining the effectiveness of certain training or instructional methods and techniques.

(iii) Action planning.

An action plan consists of a list of prioritized statements drawn up by the trainee at the end of a training programme. It indicates what actions or skills he or she is committed to implement. This type of procedure not only facilitates transfer of training but can be an invaluable aid to subsequent job and performance related evaluation of the training. In particular the action plan could be the basis for the design of the follow-up questionnaire or interview schedules.

The trainer would be interested in ensuring these documents covered:

- How much of the action plan had been implemented.
- What skills had been put into practice.
- What had been “sidelined” and why.

(iv) Performance appraisal and self-appraisal.

Performance appraisal systems are a means of identifying training needs and, by the same token, can be used to ascertained whether or not the actual or potential job performance gap, giving rise to such needs, has been closed. This evaluative data can be collected in the normal course of regular staff appraisal or a special appraisal exercise could be mounted at an appropriate point after the training programme.
Self-appraisal by the job holder which is often an integral part of some appraisal systems, also can provide the trainer with information about post-training competence and transferability.

(v) Direct observation.

Direct observation of the trainees in their workplace carrying out job activities is sometimes the only realistic way of determining the influence of training on their performance. The observer would record the trainees' performance on some activity or behaviour analysis schedule or proforma. Comparisons could then be made between the results of this analysis and the activity or behaviour patterns previously assessed as being effective. This technique can be difficult to apply on jobs that have a long activity cycle or that are made up of an irregular and unpredictable sequence of activities. In addition, the presence of the observer may have an effect on the enactment of certain forms of behaviour which might lead to incorrect conclusions being drawn.

(vi) Examination of output and results.

For some positions there are indices of performance, which can be expressed in numeric form, that give a clear indication of the quantity and quality of work produced. These indices would be examined subsequent to training to determine whether the trainees were achieving the expected level of output and results. Careful attention would have to be paid to the period over which the examination or analysis was undertaken and to trainees' work environment in case influences other than the trainees' ability were affecting their output and result. Of course, this should be a consideration whatever method or technique is adopted in the follow-up study.
Fig 6.1: A Basic Scheme for Training

Source: International Marine Simulator Forum (Amsterdam, June 1989)
In view of the projected high growth rate in the local shipping industry, generation of trained maritime manpower is essential to sustain the growth. Therefore, creation and development of necessary training infrastructural facilities would need to be identified as a priority task. Realistic goals would need to be set up to develop training facilities at MSTS. Further, procurement of training aids and implementation of new courses as recommended in Master-plan and simulator training as proposed in Chapter V be made as short term policy to achieve overall improvement in qualification standards of engine room personnel of fishing vessels. In addition to above, as a long term policy, implementation of new programmes incorporated by simulator training to train marine engineer officers of merchant vessels should be undertaken.

In the coming months, considerable efforts and attention will be focused towards the task of reviewing the STCW 1978 Convention. The future standards of education, training and certification of seafarers on a world-wide basis will be decided. In the attempt to make the revision of the STCW 1978 Convention the following should be taken into account:

1. the problem of largely varying standards of seafarers competence,
2. the current and expected future shortage of seafarers, and
3. the reluctance of young people in an increasing number of countries
to take-up the sea career.

New strategies and technologies are already being considered for introduction
into the revised convention. Amongst them are the functional approach to
certification, skill-based or competency-based training, simulator training,
computer-based training and modern distance learning.

Despite all the advantages these can offer, a systematic approach to training
would have to be developed to ensure that the current needs are analysed,
training objectives clearly set, and the most effective training methods for
achieving those objectives, determined and used.

Safety training onboard ships is crucial if proper actions and procedures are to
be taken during emergencies. Simulators provide an assessment tool.
Simulators can contribute to improve training standards. Most of the
developed countries are using simulators to train their personnel in all aspect
of shipping and other maritime related activities. There is no reason why it
cannot work in Mauritius and other developing countries.

With a view to introduce new marine engineering schemes with simulator
training at the MSTS, to generate technically qualified manpower for local
shipping industry, this study makes the following recommendations:

1. A working group should be formed to analyse and develop the simulator
   training programme for marine engineers of local maritime industry. The
   programme should be integrated in the new marine engineering training
   schemes as recommended in Chapter II
2. Marine Engineering Courses with simulator training be implemented as recommended in Chapter II and Chapter V respectively.

3. A long term plan is required to be drawn to create necessary infrastructural facilities, in a phased manner, at MSTS. The facilities are composed of a full fledge workshop, training facility on diesel engines supplemented by an engine room simulator, refrigeration and air conditioning equipment, thermodynamics laboratory, marine electrical laboratory and engineering drawing facility. Creation of these facilities is essential to conduct these courses.

4. It may be mentioned that large capital outlay is required to create above facilities. Therefore, it is recommended that a Board comprising of qualified and experienced marine engineers be formed to advice the Ministry of Trade and Shipping on establishment of these facilities. This board can also be entrusted with advisory tasks on aspects such as standardisation of course curriculum, scheduling of courses and conducting examination leading to award of competency certificates.

5. Recommend that two engineering instructors be employed at the MSTS to teach mechanical and marine engineering subjects. Availability of these instructors is essential for conducting courses and also to maintain standard of the courses.

6. Guess lectures by experts in various field of maritime industry be arranged to explain current developments in shipping to students.
Finally, through simulator training, an accurate and reliable assessment of the seafarer's skill can be obtained. However, the definitions of requirements for the simulators of today and the future is complicated. There are many problems to be solved and standards to be set. Therefore, discussion at international level should be considered to solve these problems and improve the quality of simulator training for the future. Thus, simulator training should be considered as part of the STCW certification requirements.
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Appendix I

TRAINING FACILITIES - MAURITIUS SEA TRAINING SCHOOL

1. Two classrooms

2. A seaman workshop

3. A small tool workshop

4. A bosun store

5. One full size cargo batch coxing with Mac Gregor hatch cover

6. One mast with all riggings

7. One derrick complete with cargo blocks

8. One electric winch with castrol

9. Two fully equipped 26-foot glassfibre boats

10. Six dinghies for rowing and sculling exercises

11. Two sets of gravity decks

12. Four life rafts for survival training
### Appendix II

<table>
<thead>
<tr>
<th>Country/Owner</th>
<th>Type of Simulator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Low Speed MAN B&amp;W Engine, PPT2000-MC90 Work Station</td>
</tr>
<tr>
<td></td>
<td>Low Speed Diesel Engine, Operational version</td>
</tr>
<tr>
<td></td>
<td>Low Speed Diesel Engine Part Task, Colour Graphic</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Slow and Medium Speed PPT2000-Operational and Colour Graphic trainer.</td>
</tr>
<tr>
<td>Varna Maritime Academy</td>
<td>Computer Based Marine Engineering Assessment System</td>
</tr>
<tr>
<td></td>
<td>Slow and Medium Speed PPT2000-Operational and Colour Graphic trainer.</td>
</tr>
<tr>
<td>Canada</td>
<td>Slow and Medium Speed PPT2000-Operational and Colour Graphic trainer.</td>
</tr>
<tr>
<td></td>
<td>Computer Based Marine Engineering Assessment System</td>
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<tr>
<td>Marine Institute, St. John's, Newfoundland</td>
<td>Slow and Medium Speed PPT2000-Operational and Colour Graphic trainer.</td>
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<tr>
<td>Nautical Institute, Port Hawkesbury, Nova Scotia</td>
<td>Computer Based Marine Engineering Assessment System</td>
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<tr>
<td>Institut Maritime du Quebec a Rimouski, Quebec</td>
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<td>Great Lakes Marine Training Centre, Ontario</td>
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<td>China</td>
<td>UMS Instrument Simulator</td>
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<tr>
<td>Dalian Marine University</td>
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<td>Country/Owner</td>
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<td>Ålands Tekniska Skola</td>
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<td><strong>India</strong></td>
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<td>D.M.E.T., Bombay</td>
<td>UMS Instrument Simulator</td>
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<th>Country/Owner</th>
<th>Type of Simulator</th>
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<td>Escola Nautica I. de H.</td>
<td>Low Speed Diesel Engine with Colourgraphic Work Stations and connection to NMS-90 for dual purpose training</td>
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### Country/Owner

**Russia**

- Leningrad Marine School
- Novorossisk High Marine School
- Vladivostok High Marine School
- Murmansk High Marine School
- Kamchatky High Marine College
- Kaliningrad High Marine College
- Far East Technical Institute for the Fishing Industry, Vladivostok
- Vladivostok Fishing Institute
- Primorsk Shipping Company, Vladivostok
- Astrakhan Technical Institute, Tatisheva
- Nizhny Novgorod
- Vladivostok

**Singapore**

- Singapore Polytechnic
- Republic Singapore Navy

**Sweden**

- Chalmers Tekniska Högskola
- Kalmar Sjöbefällsskola
- Kalmar Sjöbefällsskola

### Type of Simulator

- **Low Speed Diesel Engine, Operational version**
- **Low Speed Diesel Engine, Operational version**
- **Low Speed Diesel Engine, Operational version**
- **Low Speed Diesel Engine, Operational version**
- **Medium Speed Diesel Engine, Operational version (M21)**
- **Medium Speed Diesel Engine, Operational version (M21)**
- **Low Speed Diesel Engine, Operational version (M21)**
- **Low Speed Diesel Engine Simulator EPP100 Part task, Operational**
- **Low Speed Diesel Engine, PPT2000-MC90 Work Station**
- **Low Speed Diesel Engine, Part task.**
- **Electrical Power Plant, Part task.**
- **Refridgeration Plant, Part task.**
- **Low Speed MAN B&W Engine, PPT2000-MC90 Work Station**
- **Low Speed MAN B&W Engine, PPT2000-MC90 Work Station**
- **Low Speed Diesel Engine with additional Colourgraphic Work Stations, Operational version**
- **High Speed Diesel Engine with additional Colourgraphic Work Stations, Operational version**
- **Low Speed Diesel Engine with additional Colourgraphic Work Stations, Operational version**
- **Low Speed MAN B&W Engine, PPT2000-MC90 Work Station**

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<thead>
<tr>
<th>Country/Owner</th>
<th>Type of Simulator</th>
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<tr>
<td><strong>Spain</strong></td>
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<tr>
<td>Escuela Oficial de Nautica de La Coruna</td>
<td>Low Speed Diesel Engine, Operational version</td>
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<tr>
<td>Instituto Polytechnico Maritimo Pesquero del Estrecho, Cadiz</td>
<td>Medium Speed Diesel Engine, Operational version</td>
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<td>Escuela de Formacion Profesional Nautica, Huelva</td>
<td>Medium Speed Diesel Engine, Operational version, Trawler version</td>
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<td><strong>UAE</strong></td>
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<tr>
<td>Arab Maritime Transport Academy</td>
<td>Low Speed Diesel Engine, Colourgraphic version</td>
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<td><strong>Ukraine</strong></td>
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<tr>
<td>Odessa Marine School</td>
<td>Low Speed Diesel Engine, Operational version</td>
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<tr>
<td><strong>USA</strong></td>
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<tr>
<td>California Maritime Academy</td>
<td>Low Speed Diesel Engine, Operational version</td>
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<tr>
<td>Massachusetts Maritime Academy</td>
<td>Low Speed Diesel Engine, Operational version</td>
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<tr>
<td>Fort Schuyler</td>
<td>Low Speed Diesel Engine, Operational version with additional Colourgraphic</td>
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<tr>
<td>State University, New York</td>
<td>Low Speed Diesel Engine, Colourgraphic version</td>
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<td>Texas A&amp;M University at Galveston</td>
<td>Low Speed Diesel Engine, PPT2000-MC90-operational version</td>
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<tr>
<td>School of Marine and Navigation - MEBA D2</td>
<td>Low Speed Diesel Engine, PPT2000-RND-Colourgraphic version</td>
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<td>Medium Speed Diesel Engine, PPT2000-M22-operational version</td>
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<td>School of Marine and Navigation - MEBA D2</td>
<td>Medium Speed Diesel Engine, PPT2000-M21-Colourgraphic version</td>
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<td>School of Marine and Navigation - MEBA D2</td>
<td>Steam Propulsion, PPT2000-ST, Colourgraphic version</td>
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<td>School of Marine and Navigation - MEBA D2</td>
<td>Diesel Electric Propulsion, PPT2000-DE, Colourgraphic version</td>
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